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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

***Scientific and Technical Aerospace Reports* (*STAR*)** is an abstract journal that provides comprehensive coverage of worldwide aerospace-related reports. It is a major product of the International Aerospace Database managed by the NASA Scientific and Technical Information (STI) Program. The coverage includes reports on aeronautics, space, and supporting disciplines. *STAR* lists current, publicly available reports entered into the NASA STI Database during the 2-week period preceding publication. An explanation of items that appear in each citation is given on the last page of each volume.

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**54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT** ..... **1932**
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**55 SPACE BIOLOGY** ..... **N.A.**
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Includes computer programs, routines, algorithms, and specific applications, e.g., CAD/CAM.

**62 COMPUTER SYSTEMS** ..... **1962**
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**63 CYBERNETICS** ..... **1964**
Includes feedback and control theory, artificial intelligence, robotics and expert systems. For related information see also *54 Man/System Technology and Life Support.*

**64 NUMERICAL ANALYSIS** ..... **1969**
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Includes elementary and nuclear particles; and reactor theory. For space radiation see *93 Space Radiation.*

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Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics. For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

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**82 DOCUMENTATION AND INFORMATION SCIENCE** ..... **1996**
Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography. For computer documentation see *61 Computer Programming and Software.*

**83 ECONOMICS AND COST ANALYSIS** ..... **N.A.**
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**84 LAW, POLITICAL SCIENCE AND SPACE POLICY** ..... **1999**
Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

**85 URBAN TECHNOLOGY AND TRANSPORTATION** ..... **2000**
Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation. For related information see *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

## SPACE SCIENCES For related information see also *Geosciences.*

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**89 ASTRONOMY** ..... **2000**
Includes radio, gamma-ray, and infrared astronomy; and astrometry.

**90 ASTROPHYSICS** ..... **2001**
Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust. For related information see also *75 Plasma Physics.*

**91 LUNAR AND PLANETARY EXPLORATION** ..... **2007**
Includes planetology; and manned and unmanned flights. For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

**92 SOLAR PHYSICS** ..... **N.A.**
Includes solar activity, solar flares, solar radiation and sunspots. For related information see *93 Space Radiation.*

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Includes cosmic radiation; and inner and outer earth's radiation belts. For biological effects of radiation see *52 Aerospace Medicine.* For theory see *73 Nuclear and High-Energy Physics.*

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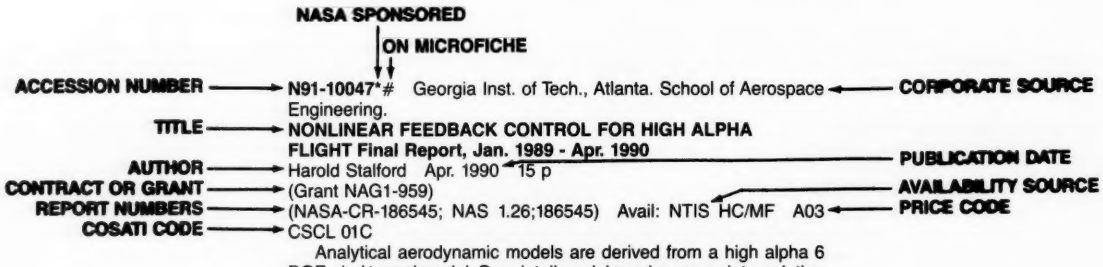


Analytical aerodynamic models are derived from a high alpha 6 DOF wind tunnel model. One detail model requires some interpolation between nonlinear functions of alpha. One analytical model requires no interpolation and as such is a completely continuous model. Flight path optimization is conducted on the basic maneuvers: half-loop, 90 degree pitch-up, and level turn. The optimal control analysis uses the derived analytical model in the equations of motion and is based on both moment and force equations. The maximum principle solution for the half-loop is poststall trajectory performing the half-loop in 13.6 seconds. The agility induced by thrust vectoring capability provided a minimum effect on reducing the maneuver time. By means of thrust vectoring control the 90 degrees pitch-up maneuver can be executed in a small place over a short time interval. The agility capability of thrust vectoring is quite beneficial for pitch-up maneuvers. The level turn results are based currently on only outer layer solutions of singular pertrubation. Poststall solutions provide high turn rates but generate higher losses of energy than that of classical sustained solutions.

Author

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# Scientific and Technical Aerospace Reports

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## 01 AERONAUTICS (GENERAL)

**N91-20040#** Air War Coll., Maxwell AFB, AL.
**THE STRATEGIC BOMBER AND LOW-INTENSITY CONFLICT**
John A. Breed May 1990 75 p
(AD-A229938) Avail: NTIS HC/MF A04 CSCL 15/6

The value of strategic (long range) bombers as a key component of the United States nuclear deterrent force has been well established. The utility of employing these same aircraft in conventional operations has been demonstrated, although less well accepted. As the probability of major conflict with the Soviet Union declines in the 1990s, the likelihood that the United States will find itself engaged in a Third World conflict is increasing. This paper examines the feasibility of employing the strategic bomber in low-intensity conflict scenarios. Furthermore, it proposes that the conventional B-52G has the potential to increase the United States options, flexibility, and responsiveness to conflicts in the Third World. The B-52 is an available and cost effective interim alternative until either the B-1b or b-2 can fully assume a dedicated conventional role. GRA

**N91-20041#** Logistics Management Inst., Bethesda, MD.
**ENHANCING AIRCRAFT UTILIZATION: IMPROVED USE OF CARGO-HOLDING TIME Final Report**
Lawrence Schwartz Sep. 1990 30 p
(Contract MDA903-90-C-0006)
(AD-A230402; LMI-AC001R2) Avail: NTIS HC/MF A03 CSCL 05/1

The Military Airlift Command (MAC) has incurred lower aircraft utilization rates since FY87. Aircraft efficiency has suffered as airlift demands of the Military Services declined, prompted by shrinking transportation budgets. To improve its aircraft efficiency, MAC has experimented with extending the length of time it holds cargo at aerial ports of embarkation beyond the 48-hour limit set by the Uniform Material Movement Issue Priority System (UMMIPS). A statistical model shows that such cargo-holding time extensions can be a powerful tool for improving the utilization of this aircraft. Moreover, MAC found that timely deliveries need not to suffer with cargo holding time extensions: when Julian delivery dates are not constraining, MAC can use some of the extra time to extend its cargo-holding time; when Julian delivery dates are constraining, MAC can reduce its other possession times to compensate for the increased cargo-holding time; and when expeditious shipments are designated, MAC can focus on standard UMMIPS times. MAC should be given formal managerial authority to focus on meeting the particular delivery requirement of each shipment, not on the currently arbitrary and uniform timeframes. To obtain and use this new authority, we recommend certain revisions to UMMIPS, modifications to MAC's operating procedures, and changes to performance reporting. GRA

**N91-20042#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**ANALYSIS OF THE MAINTAINABILITY OF THE F-16 A/B ADVANCED MULTI-PURPOSE SUPPORT ENVIRONMENT M.S. Thesis**
Vaughn K. Grace Dec. 1990 285 p
(AD-A230604; AFIT/GCS/ENC/90D-1) Avail: NTIS HC/MF A13 CSCL 12/5

The goal of this thesis was to develop an object oriented design methodology for use within the F-16 A/B advanced multi-purpose support environment (AMPSE). The instrument landing system (ILS) was the software simulation model chosen to be redesigned using the object oriented design guidelines developed over the course of this study. The new ILS design was then implemented in the Ada programming language. This model served as a prototype to test the feasibility of developing object oriented flight simulator environments. This thesis presents background on the F-16 A/B AMPSE system, the structure of the current system and simulation, guidelines for redesigning the current F-16 A/B AMPSE system, and guidelines for developing future object oriented AMPSE systems. GRA

**N91-20710*#** Aerospace Medical Research Labs., Wright-Patterson AFB, OH.
**A SPATIAL DISORIENTATION PREDICTOR DEVICE TO ENHANCE PILOT SITUATIONAL AWARENESS REGARDING AIRCRAFT ATTITUDE**
T. L. Chelette, Daniel W. Repperger, and W. B. Albery *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 536-541 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 01D

## 02 AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer.*

**N91-20043*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**WALL-INTERFERENCE ASSESSMENT AND CORRECTIONS FOR TRANSONIC NACA 0012 AIRFOIL DATA FROM VARIOUS WIND TUNNELS M.S. Thesis - George Washington Univ., 1988**
Lawrence L. Green and Perry A. Newman Apr. 1991 63 p Presented at AIAA Meeting, Honolulu, HI, 8-10 Jun. 1987
(NASA-TP-3070; L-16721; NAS 1.60:3070; AIAA-87-1431) Avail: NTIS HC/MF A04 CSCL 01A

A nonlinear, four wall, post-test wall interference assessment/correction (WIAC) code was developed for transonic airfoil data from solid wall wind tunnels with flexibly adaptable top and bottom walls. The WIAC code was applied over a broad range of test conditions to four sets of NACA 0012 airfoil data, from two different adaptive wall wind tunnels. The data include many test points for fully adapted walls, as well as numerous partially adapted and unadapted test points, which together represent many different model/tunnel configurations and possible wall interference effects. Small corrections to the measured Mach numbers and angles of attack were obtained from the WIAC code even for fully adapted data; these corrections generally improve the correlation among the various sets of airfoil data and simultaneously improve the correlation of the data with calculations

for a 2-D, free air, Navier-Stokes code. The WIAC corrections for airfoil data taken in fully adapted wall test sections are shown to be significantly smaller than those for comparable airfoil data from straight, slotted wall test sections. This indicates, as expected, a lesser degree of wall interference in the adapted wall tunnels relative to the slotted wall tunnels. Application of the WIAC code to this data was, however, somewhat more difficult and time consuming than initially expected from similar previous experience with WIAC applications to slotted wall data. Author

**N91-20044*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**NASA LOW-SPEED CENTRIFUGAL COMPRESSOR FOR 3-D VISCOUS CODE ASSESSMENT AND FUNDAMENTAL FLOW PHYSICS RESEARCH**

M. D. Hathaway, J. R. Wood, and C. A. Wasserbauer (Sverdrup Technology, Inc., Brook Park, OH.) 1991 15 p Presented at the 36th International Gas Turbine and Aeroengine Congress and Exposition, Orlando, FL, 3-6 Jun. 1991; sponsored by the American Society of Mechanical Engineers

(DA Proj. 1L1-61102-AH-45)

(NASA-TM-103710; E-5938; NAS 1.15:103710; AVSCOM-TR-91-C-003) Avail: NTIS HC/MF A03 CSCL 01A

A low speed centrifugal compressor facility recently built by the NASA Lewis Research Center is described. The purpose of this facility is to obtain detailed flow field measurements for computational fluid dynamic code assessment and flow physics modeling in support of Army and NASA efforts to advance small gas turbine engine technology. The facility is heavily instrumented with pressure and temperature probes, both in the stationary and rotating frames of reference, and has provisions for flow visualization and laser velocimetry. The facility will accommodate rotational speeds to 2400 rpm and is rated at pressures to 1.25 atm. The initial compressor stage being tested is geometrically and dynamically representative of modern high-performance centrifugal compressor stages with the exception of Mach number levels. Preliminary experimental investigations of inlet and exit flow uniformly and measurement repeatability are presented. These results demonstrate the high quality of the data which may be expected from this facility. The significance of synergism between computational fluid dynamic analysis and experimentation throughout the development of the low speed centrifugal compressor facility is demonstrated. Author

**N91-20045*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**TRANSONIC AERODYNAMICS OF DENSE GASES M.S. Thesis - Virginia Polytechnic Inst. and State Univ., Apr. 1990**

Sybil Huang Morren Jan. 1991 84 p

(NASA-TM-103722; E-5953; NAS 1.15:103722) Avail: NTIS HC/MF A05 CSCL 01A

Transonic flow of dense gases for two-dimensional, steady-state, flow over a NACA 0012 airfoil was predicted analytically. The computer code used to model the dense gas behavior was a modified version of Jameson's FL052 airfoil code. The modifications to the code enabled modeling the dense gas behavior near the saturated vapor curve and critical pressure region where the fundamental derivative, Gamma, is negative. This negative Gamma region is of interest because the nonclassical gas behavior such as formation and propagation of expansion shocks, and the disintegration of inadmissible compression shocks may exist. The results indicated that dense gases with undisturbed thermodynamic states in the negative Gamma region show a significant reduction in the extent of the transonic regime as compared to that predicted by the perfect gas theory. The results support existing theories and predictions of the nonclassical, dense gas behavior from previous investigations. Author

**N91-20046*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**STRUCTURAL DYNAMICS DIVISION RESEARCH AND TECHNOLOGY ACCOMPLISHMENTS FOR FISCAL YEAR 1990 AND PLANS FOR FISCAL YEAR 1991**

Eleanor C. Wynne Jan. 1991 225 p

(NASA-TM-102770; NAS 1.15:102770) Avail: NTIS HC/MF A10 CSCL 01A

The research accomplishments of the Structural Dynamics Division for F.Y. 1991 are presented. The work is discussed in terms of highlights of accomplishments during the past year and plans for the current year as they relate to 5-year plans and the objectives of each technical area. Included is research on unsteady aerodynamics, helicopter rotors, computational fluid dynamics, oscillations of leading edge flaps of a delta wing, and aircraft wing loads. Author

**N91-20047*#** Arizona Univ., Tucson.

**LEADING-EDGE RECEPTIVITY FOR BLUNT-NOSE BODIES Annual Progress Report, 1 May 1990 - 30 Apr. 1991**

Edward J. Kerschen Apr. 1991 3619 p

(Grant NAG1-1135)

(NASA-CR-188063; NAS 1.26:188063) Avail: NTIS HC/MF A99 CSCL 01A

This research program investigates boundary-layer receptivity in the leading-edge region for bodies with blunt leading edges. Receptivity theory provides the link between the unsteady distrubance environment in the free stream and the initial amplitudes of the instability waves in the boundary layer. This is a critical problem which must be addressed in order to develop more accurate prediction methods for boundary-layer transition. The first phase of this project examines the effects of leading-edge bluntness and aerodynamic loading for low Mach number flows. In the second phase of the project, the investigation is extended to supersonic Mach numbers. Singular perturbation techniques are utilized to develop an asymptotic theory for high Reynolds numbers. In the first year, the asymptotic theory was developed for leading-edge receptivity in low Mach number flows. The case of a parabolic nose is considered. Substantial progress was made on the Navier-Sotkes computations. Analytical solutions for the steady and unsteady potential flow fields were incorporated into the code, greatly expanding the types of free-stream disturbances that can be considered while also significantly reducing the the computational requirements. The time-stepping algorithm was modified so that the potential flow perturbations induced by the unsteady pressure field are directly introduced throughout the computational domain, avoiding an artificial 'numerical diffusion' of these from the outer boundary. In addition, the start-up process was modified by introducing the transient Stokes wave solution into the downstream boundary conditions. Author

**N91-20048*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**SPATIAL ADAPTION PROCEDURES ON UNSTRUCTURED MESHES FOR ACCURATE UNSTEADY AERODYNAMIC FLOW COMPUTATION**

Russ D. Rausch, John T. Batina, and Henry T. Y. Yang (Purdue Univ., West Lafayette, IN.) Mar. 1991 17 p Presented at the AIAA/ASME/ASCE/AHS/ASC 32nd Structures, Structural Dynamics and Materials Conference, Baltimore, MD, 8-10 Apr. 1991

(Grant NGT-50406)

(NASA-TM-104039; NAS 1.15:104039; AIAA-91-1106) Avail: NTIS HC/MF A03 CSCL 01A

Spatial adaption procedures for the accurate and efficient solution of steady and unsteady inviscid flow problems are described. The adaption procedures were developed and implemented within a two-dimensional unstructured-grid upwind-type Euler code. These procedures involve mesh enrichment and mesh coarsening to either add points in a high gradient region or the flow or remove points where they are not needed, respectively, to produce solutions of high spatial accuracy at minimal computational costs. A detailed description is given of the enrichment and coarsening procedures and comparisons with alternative results and experimental data are presented to provide an assessment of the accuracy and efficiency of the capability. Steady and unsteady transonic results, obtained using spatial adaption for the NACA 0012 airfoil, are shown to be of high

spatial accuracy, primarily in that the shock waves are very sharply captured. The results were obtained with a computational savings of a factor of approximately fifty-three for a steady case and as much as twenty-five for the unsteady cases. Author

**N91-20049#** Colorado Univ., Boulder.
**VORTEX PATTERNS BEHIND AIRFOILS IN STREAMWISE OSCILLATION**
P. Freymuth, R. Tarasewicz, and W. Bank 7 Nov. 1989 7 p
(Contract F49620-84-C-0065)
(AD-A229883; FJSRL-PR-90-0018) Avail: NTIS HC/MF A02 CSCL 01/1

Streamwise oscillation or lunging airfoils have been previously investigated for their lift characteristics with only minor attention given to flow visualization. Therefore, a limited parametric exploration of the two-dimensional vortex patterns of lunging airfoils, which supplement similar investigations in other separating flow configurations, is emphasized. GRA

**N91-20050#** Sverdrup Technology, Inc., Arnold AFS, TN.
**DEVELOPMENT OF A FREE-JET FOREBODY SIMULATOR DESIGN OPTIMIZATION METHOD Final Report, 1 Oct. 1988 - 30 Jun. 1990**
David H. Huddleston Dec. 1990 78 p Prepared in cooperation with Arnold Engineering Development Center, Arnold AFS, TN
(AD-A230162; AEDC-TR-90-22) Avail: NTIS HC/MF A05 CSCL 21/5

An aerodynamic design optimization technique is presented that couples direct optimization algorithms with the analysis capability provided by appropriate computational fluid dynamics (CFD) programs. This technique is intended to be an aid in designing the aerodynamic shapes and establishing test conditions required for the successful simulation of aircraft engine inlet conditions in a ground test environment. However, the method is also applicable to other aerodynamic design problems such as airfoil design, turbomachinery cascade design, and nozzle design. The approach involves minimization of a nonlinear least-squares objective function that may be defined in a region remote to the geometric surface being optimized. In this study, finite, difference Euler and Navier-Stokes codes were applied to obtain the objective function evaluation, although the applied optimization method can be coupled with any appropriate CFD analysis technique. Using CFD to compute design space gradients within an optimization algorithm has received little prior attention in the literature. It is demonstrated that CFD can be used in this manner by applying the developed design technique to a variety of aerodynamic design problems. Results are presented for several typical aerospace examples, including inviscid and viscous flow over airfoils flows in convergent/divergent nozzles in both two and three dimensions, and supersonic flow about a planar forebody simulator. GRA

**N91-20051#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**COMPUTATIONAL INVESTIGATION OF CIRCULATION CONTROL TURBULENCE MODELING M.S. Thesis**
T. B. Scruggs Dec. 1990 133 p
(AD-A230440; AFIT/GAE/ENY/90D-27) Avail: NTIS HC/MF A07 CSCL 01/1

A computational study of the turbulence model parameters and the effect on the flow field of a circulation control airfoil was conducted. A Beam-Warming algorithm with a modified Baldwin-Lomax turbulence model was used to solve the Navier-Stokes equations. A comparison between the effects of the Bradshaw constant on the flow field about the cylinder and the flow field about an airfoil were to be made. The lack of a steady converged solution for the cylinder precluded the analysis of the flow field about a cylinder. For the airfoil, the separation point moves rearward and an enhanced vortex pattern is developed as the Bradshaw constant is increased. Once a high enough value is reached, the curvature correction has minimal effect. The results obtained indicate that a better turbulence model must be employed before CFD can be used to accurately predict the flow around a circulation control airfoil. GRA

**N91-20052*#** Old Dominion Univ., Norfolk, VA. Dept. of Mechanical Engineering and Mechanics.
**RADIATIVE INTERACTIONS IN CHEMICALLY REACTING SUPERSONIC INTERNAL FLOWS Progress Report, period ended 31 Dec. 1990**
S. N. Tiwari and R. Chandrasekhar Apr. 1991 59 p Previously announced in IAA as A91-21473 (AIAA-91-0373), and A91-21539 (AIAA-91-0572)
(Grant NAG1-423)
(NASA-CR-188067; NAS 1.26:188067; AIAA-91-0373; AIAA-91-0572) Avail: NTIS HC/MF A04 CSCL 01A

The two-dimensional, elliptic Navier-Stokes equations are used to investigate supersonic flows with finite-rate chemistry and radiation for hydrogen-air systems. The chemistry source terms in the species equation is treated implicitly to alleviate the stiffness associated with fast reactions. The explicit, unsplit MacCormack finite-difference scheme is used to advance the governing equations in time, until convergence is achieved. The specific problem considered is the premixed flow in a channel with a ten-degree compression ramp. Three different chemistry models are used, accounting for increasing number of reactions and participating species. Two chemistry models assure nitrogen as inert, while the third model accounts for nitrogen reactions and NO(x) formation. The tangent slab approximation is used in the radiative flux formulation. A pseudo-gray model is used to represent the absorption-emission characteristics of the participating species. Results obtained for specific conditions indicate that the radiative interactions vary substantially, depending on reactions involving HO2 and NO species and that this can have a significant influence on the flowfield. Author

**N91-20053#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**INVESTIGATION OF THE HIGH ANGLE OF ATTACK DYNAMICS OF THE F-15B USING BIFURCATION ANALYSIS M.S. Thesis**
Robert J. McDonnell Dec. 1990 123 p
(AD-A230462; AFIT/GAE/ENY/90D-16) Avail: NTIS HC/MF A06 CSCL 01/1

Previous studies predicted the F-15B high angle of attack and flat spin behavior using bifurcation analysis. These studies varied control surface deflections to find equilibrium and periodic solutions. The purpose of this research was to use bifurcation analysis to predict the F-15B high angle attack and flat spin behavior as a result of variable thrust, asymmetric thrust, and thrust vectoring. Using a previously developed model of the F-15, bifurcation analysis and continuation methods were used to map out the equilibrium and periodic solutions of the model as a function of the thrust parameters. A baseline bifurcation diagram,, as a function of alpha and elevator deflection angel, of the equilibrium solutions for the F-15 was developed. Thrust was varied and changes were identified. Thrust asymmetries were introduced and their effect on entering and recovering from spins was identified. Thrust vectoring was introduced to see how pitch and yaw vectoring can aid in the entry and recovery from spins. Where deemed necessary, time history simulations were presented to further explain F-15 behavior. GRA

**N91-20054#** Applied and Theoretical Mechanics, Inc., Oakland, CA.
**HEAT TRANSFER PREDICTIONS OF HYPERSONIC TRANSITIONAL FLOWS Final Report, 1 Oct. 1989 - 31 Oct 1990**
Joelle M. Champney Nov. 1990 45 p
(Contract F49620-90-C-0004)
(AD-A230748; ATM-TR-90-025; AFOSR-90-1188TR) Avail: NTIS HC/MF A03 CSCL 20/13

A numerical model to solve transition process observed in hypersonic flows over cones has been developed. Low Reynolds number two-equation turbulence models were employed with a production term modification (PTM) technique. The approach determined the extent of the transition zone. The onset of transition was imposed using experimental measurements when available.

When not available, the onset of transition was determined by a stability criterion which is related to the Bushnell-Reshotko transition criterion. The PTM technique was incorporated into a NASA-Ames implicit Reynolds averaged Navier Stokes solver, the TURF code, and tested for transitional hypersonic flows over flat plates. The model parameters were tuned as a function of free stream Mach number. The PTM technique was also tested for transitional hypersonic flows over sharp cones and blunt cones for a variety of flow conditions. Comparisons of computed heat transfer with experimental measurements are shown to be good.
GRA

**N91-20055*#** National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
**IN-FLIGHT FLOW VISUALIZATION CHARACTERISTICS OF THE NASA F-18 HIGH ALPHA RESEARCH VEHICLE AT HIGH ANGLES OF ATTACK**
David F. Fisher, John H. DelFrate, and David M. Richwine (PRC Systems Services Co., Edwards, CA.) Washington : May 1991 34 p Previously announced in IAA as A90-45439 LIMITED REPRODUCIBILITY: More than 20% of this document may be affected by color photographs Original contains color illustrations
(NASA-TM-4193; H-1576; NAS 1.15:4193) Avail: NTIS HC/MF A03; 22 functional color pages CSCL 01A

Surface and off-surface flow visualization techniques were used to visualize the 3-D separated flows on the NASA F-18 high alpha research vehicle at high angles of attack. Results near the alpha = 25 to 26 deg and alpha = 45 to 49 deg are presented. Both the forebody and leading edge extension (LEX) vortex cores and breakdown locations were visualized using smoke. Forebody and LEX vortex separation lines on the surface were defined using an emitted fluid technique. A laminar separation bubble was also detected on the nose cone using the emitted fluid technique and was similar to that observed in the wind tunnel test, but not as extensive. Regions of attached, separated, and vortical flow were noted on the wing and the leading edge flap using tufts and flow cones, and compared well with limited wind tunnel results.
Author

**N91-20056#** Royal Aerospace Establishment, Farnborough (England).
**TEMPERATURE ERROR COMPENSATION APPLIED TO PRESSURE MEASUREMENTS TAKEN WITH MINIATURE SEMICONDUCTOR PRESSURE TRANSDUCERS IN A HIGH-SPEED RESEARCH COMPRESSOR**
M. A. Cherrett 30 Oct. 1990 25 p Presented at the 10th International Symposium on Measuring Techniques for Transonic and Supersonic Flows in Cascades and Turbomachines, Brussels, Belgium, 17-18 Sep. 1990
(RAE-TM-P-1192; BR115684; ETN-91-99004) Copyright Avail: NTIS HC/MF A03

An easily implemented system, developed for the compensation of temperature errors for measurements taken using miniature semiconductor pressure transducers to investigate unsteady viscous flows within high speed axial compressors and fans, is discussed. Data was taken, using this compensation system, from a single sensor traverse probe in a high speed research compressor. Implementation of the system is discussed and comparisons of the tranducer measurements with conventional pneumatic data are made. An automated facility for steady state pressure and temperature calibration of tranducers is described.
ESA

**N91-20057#** Cranfield Inst. of Tech., Bedford (England). Coll. of Aeronautics.
**PRELIMINARY STUDIES FOR AIRCRAFT PARAMETER ESTIMATION USING MODIFIED STEPWISE RECOGNITION Annual Report, Nov. 1989**
H. A. Hinds and M. V. Cook Nov. 1989 54 p
(Cranfield-Aero-8911; ISBN-1-871564-02-6; ETN-91-99012)
Avail: NTIS HC/MF A04; Cranfield Inst. of Technology, Coll. of Aeronautics, Cranfield, Bedford MK43 0AL, England, HC 8 sterling pounds

The application of the parameter estimation Modified Stepwise Regression (MSR) model to an aircraft model is discussed. A dynamic wind tunnel test facility in which the model is suspended with four degrees of freedom is described. Calibration and dynamic stability of the control surface angles carried out on a British Aerospace Hawk model are discussed. The computerization of the procedure for aircraft equations of motion in FORTRAN 77 is outlined. Aircraft simulation using an Advanced Continuous Simulation Language (ACSL) and a complete set of stability and control derivatives for the Hawk is described. Hawk model kinematics, attitude rate information, the MSR method, mathematical model formulation and the MSR software are discussed. Current status and future work of the facility are outlined.
ESA

**N91-20058#** Cranfield Inst. of Tech., Bedford (England). Coll. of Aeronautics.
**APPLICATION OF MODIFIED STEPWISE REGRESSION FOR THE ESTIMATION OF AIRCRAFT STABILITY AND CONTROL PARAMETERS Quarterly Report No. 3**
H. A. Hinds and M. V. Cook Jul. 1989 36 p
(Cranfield-Aero-9008; ISBN-1-871564-06-9; ETN-91-99014)
Avail: NTIS HC/MF A03; Cranfield Inst. of Technology, Coll. of Aeronautics, Cranfield, Bedford MK43 0AL, England, HC 8 sterling pounds

Progress on the research program concerned with the use of a Modified Stepwise Regression Method (MSR) for estimating the stability and control derivatives of a British Aerospace Hawk aircraft from data obtained by the use of a scaled model on a dynamic wind tunnel test is discussed. The longitudinal and lateral equations of motion for the ACSL (Advanced Continuous Simulation Language) digital simulation program which will provide data to test the FORTRAN 77 MSR program are given. Estimation of full scale Hawk derivatives for ACSL program, improvements to the lateral simulation programs, modeling of control surface inputs, Hawk model and dynamic rig status, derivation of aircraft attitude rates and the MSR procedure are described. Future objectives are summarized and results reported so far lead to the conclusion that the ACSL program represents the full scale Hawk satisfactorily.
ESA

**N91-20059#** Sandia National Labs., Albuquerque, NM.
**DESIGN AND PERFORMANCE OF A PARACHUTE FOR THE RECOVERY OF A 760-LB PAYLOAD**
D. E. Waye 1991 11 p Presented at the 11th AIAA Aerodynamic Decelerator Systems Technology Conference, San Diego, CA, 9-11 Apr. 1991
(Contract DE-AC04-76DP-00789)
(DE91-007509; SAND-90-2158C; CONF-9104171-3) Avail: NTIS HC/MF A03

A 26 ft. diameter ribbon parachute deployed using a pilot parachute system has been developed at Sandia National Laboratories for the recovery of a 760 lb. payload released at subsonic and transonic speeds. The wide range of deployment dynamic pressures led to the design, utilizing wind tunnel testing and computer simulation, of a unique pilot parachute system verified in full-scale flight tests. Performance data from 20 full-scale flight tests were used to evaluate system performance and structural validity. The concical ribbon parachute design chosen for this development effort follows the practice of previous Sandia National Laboratory parachute development programs for high performance airdropped payloads. The design process for this parachute system included a tradeoff study to evaluate and compare the performance between an equivalent drag area 26 ft. diameter single parachute system and a cluster system of three 14 ft. diameter parachutes. The results showed a small advantage for the cluster system in inflation and initial deceleration characteristics. However, the higher cost, higher weight, greater packing complexity and greater risk involved in the development of the cluster system outweighed the performance advantages and led to the choice of the 26 ft. diameter parachute as the baseline design for the development. This paper

describes the design and performance of the 26 ft. diameter parachute which was chosen for the recovery of a 760 lb. payload. The results of 20 full-scale flight test of this parachute system are summarized. DOE

**N91-20060#** Lawrence Livermore National Lab., CA.
**AERODYNAMICS MODELING OF TOWED-CABLE DYNAMICS**
S. W. Kang and V. R. Latorre 17 Jan. 1991 45 p
(Contract W-7405-eng-48)
(DE91-008426; UCRL-ID-106509) Avail: NTIS HC/MF A03

The dynamics of a cable/drogue system being towed by an orbiting aircraft has been investigated as a part of an LTWA project for the Naval Air Systems Command. We present here a status report on the tasks performed under Phase 1. The following tasks were accomplished under Phase 1: A literature survey on the towed-cable motion problem has been conducted. While both static (steady-state) and dynamic (transient) analyses exist in the literature, no single, comprehensive analysis exists that directly addresses the present problem. However, the survey also reveals that, when judiciously applied, these past analyses can serve as useful building blocks for approaching the present problem. A numerical model that addresses several aspects of the towed-cable dynamic problem has been adapted from a Canadian underwater code for the present aerodynamic situation. This modified code, called TOWDYN, analyzes the effects of gravity, tension, aerodynamic drag, and wind. Preliminary results from this code demonstrate that the wind effects alone CAN generate the drogue oscillation behavior, i.e., the yo-yo phenomenon. This code also will serve as a benchmark code for checking the accuracy of a more general and complete R and D model code. Efforts were initiated to develop a general R and D model supercomputer code that also takes into account other physical factors, such as induced oscillations and bending stiffness. This general code will be able to evaluate the relative impacts of the various physical parameters, which may become important under certain conditions. This R and D code will also enable development of a simpler operational code that can be used by the Naval Air personnel in the field. DOE

**N91-20061*#** Institute for Computer Applications in Science and Engineering, Hampton, VA.
**DIRECT SIMULATION OF COMPRESSIBLE TURBULENCE IN A SHEAR FLOW Final Report**
S. Sarkar, G. Erlebacher, and M. Y. Hussaini Mar. 1991 42 p
Submitted for publication
(Contract NAS1-18605)
(NASA-CR-187537; ICASE-91-29; NAS 1.26:187537) Avail: NTIS HC/MF A03 CSCL 01A

Compressibility effects on the turbulence in homogeneous shear flow are investigated. The growth of the turbulent kinetic energy was found to decrease with increasing Mach number: a phenomenon which is similar to the reduction of turbulent velocity intensities observed in experiments on supersonic free shear layers. An examination of the turbulent energy budget shows that both the compressible dissipation and the pressure-dilatation contribute to the decrease in the growth of kinetic energy. The pressure-dilatation is predominantly negative in homogeneous shear flow, in contrast to its predominantly positive behavior in isotropic turbulence. The different signs of the pressure-dilatation are explained by theoretical consideration of the equations for the pressure variance and density variance. Previously, the following results were obtained for isotropic turbulence: (1) the normalized compressible dissipation is of O(M(sub t)(exp 2)); and (2) there is approximate equipartition between the kinetic and potential energies associated with the fluctuating compressible mode. Both of these results were substantiated in the case of homogeneous shear. The dilatation field is significantly more skewed and intermittent than the vorticity field. Strong compressions seem to be more likely than strong expansions. Author

**N91-20062*#** Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.
**VISUALIZATION OF LEADING EDGE VORTICES ON A SERIES OF FLAT PLATE DELTA WINGS**
Francis M. Payne, T. Terry Ng, and Robert C. Nelson Washington Apr. 1991 81 p
(Grant NAG2-258)
(NASA-CR-4320; A-90094; NAS 1.26:4320) Avail: NTIS HC/MF A05 CSCL 01A

A summary of flow visualization data obtained as part of NASA Grant NAG2-258 is presented. During the course of this study, many still and high speed motion pictures were taken of the leading edge vortices on a series of flat plate delta wings at varying angles of attack. The purpose is to present a systematic collection of photographs showing the state of vortices as a function of the angle of attack for the four models tested. Author

**N91-20063*#** Institute for Computer Applications in Science and Engineering, Hampton, VA.
**UNSTRUCTURED AND ADAPTIVE MESH GENERATION FOR HIGH REYNOLDS NUMBER VISCOUS FLOWS Final Report**
Dimitri J. Mavriplis Feb. 1991 26 p Prepared for presentation of the 3rd International Conference on Numerical Grid Generation Conference, Barcelona, Spain, 3-7 Jun. 1991
(Contract NAS1-18605)
(NASA-CR-187534; ICASE-91-25; NAS 1.26:187534) Avail: NTIS HC/MF A03 CSCL 01A

A method for generating and adaptively refining a highly stretched unstructured mesh suitable for the computation of high-Reynolds-number viscous flows about arbitrary two-dimensional geometries was developed. The method is based on the Delaunay triangulation of a predetermined set of points and employs a local mapping in order to achieve the high stretching rates required in the boundary-layer and wake regions. The initial mesh-point distribution is determined in a geometry-adaptive manner which clusters points in regions of high curvature and sharp corners. Adaptive mesh refinement is achieved by adding new points in regions of large flow gradients, and locally retriangulating; thus, obviating the need for global mesh regeneration. Initial and adapted meshes about complex multi-element airfoil geometries are shown and compressible flow solutions are computed on these meshes. Author

# 03 AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

For related information see also *16 Space Transportation* and *85 Urban Technology and Transportation.*

**N91-20064#** Federal Aviation Administration, Atlantic City, NJ.
**DEVELOPMENT AND GROWTH OF INACCESSIBLE AIRCRAFT FIRES UNDER INFLIGHT AIRFLOW CONDITIONS Final Report**
David Blake Feb. 1991 33 p
(DOT/FAA/CT-91/2) Avail: NTIS HC/MF A03

An attempt was made to determine the likelihood of fire development and growth in accessible areas of an aircraft and the resulting hazards to cabin occupants from these fires. Numerous inflight fires or smoke events occur in accessible areas but are controlled by the crew or self-extinguish. Fatal inflight fires are rare events but start in inaccessible areas. Some 57 tests of hidden inflight fires in a section of a DC-10 aircraft were performed. The fires were started behind sidewall panels, below the cabin floor, above the cabin ceiling, in overhead stowage bins, in lavatory trash receptacles, and adjacent to lavatory flush motors. The conclusions are that although uncontaminated insulation blankets did not readily support combustion, contaminated insulation blankets were found to support combustion and the built in Halon 1301 trash receptacle extinguishers did not always completely extinguish trash fires. Author

**N91-20065*#** North Carolina Agricultural and Technical State Univ., Greensboro. Dept. of Manufacturing Systems.
**DESIGN AND FABRICATION OF THE NASA HL-20 SUPPORT CRADLE AND INTERIOR MOCKUP Final Report**
Thurman Exum 15 Apr. 1991 13 p
(Grant NAGw-1331)
(NASA-CR-188003; NAS 1.26:188003) Avail: NTIS HC/MF A03 CSCL 01C

An extensive test program involving analysis in both the horizontal and vertical attitudes of the HL-20 will be conducted by NASA-Langley. This necessitated the fabrication of a steel support cradle for the composite Personnel Launch System (PLS) model and an internal mockup to simulate the pilot and passenger compartments. Author

**N91-20066#** Sandia National Labs., Albuquerque, NM.
**F111 CREW ESCAPE MODULE PILOT PARACHUTE**
E. L. Tadios 1991 6 p Presented at the 11th AIAA Aerodynamic Decelerator Systems Technology Conference, San Diego, CA, 9-11 Apr. 1991
(Contract DE-AC04-76DP-00789)
(DE91-007573; SAND-90-2124C; CONF-9104171-5) Avail: NTIS HC/MF A02

A successfully deployment of a parachute system highly depends on the efficiency of the deployment device and/or method. There are several existing methods and devices that may be considered for a deployment system. For the F111 Crew Escape Module (CEM), the recovery parachute system deployment is initiated by the firing of a catapult that ejects the complete system from the CEM. At first motion of the pack, a drogue gun is fired, which deploys the pilot parachute system. The pilot parachute system then deploys the main parachute system, which consists of a cluster of three 49 ft diameter parachutes. The pilot parachute system which extracts the F111 Crew Escape Module recovery parachute system must provide reasonable bag strip velocities throughout the flight envelope (10 to 300 psf). The pilot parachute system must, therefore, have sufficient drag area at the lower dynamic pressures and a reduced drag area at the high end of the flight envelope. The final design that was developed was a dual parachute system which consists of a 5 ft diameter guide surface parachute tethered inside a 10 ft diameter flat circular parachute. The high drag area is sustained at the low dynamic pressures by keeping both parachutes intact. The drag area is reduced at the higher extreme by allowing the 10 ft parachute attachment to fail. The discussions to follow describe in detail how the system was developed. DOE

**N91-20120*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**NASA'S AIRCRAFT ICING TECHNOLOGY PROGRAM**
John J. Reinmann *In its* Aeropropulsion 1991 Mar. 1991 24 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 01C

## 04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

For related information see also *17 Space Communications, Spacecraft Communications, Command and Tracking* and *Communications and Radar.*

**N91-20067#** Federal Aviation Administration, Washington, DC. Aviation System.
**CAPITAL INVESTMENT PLAN**
Dec. 1990 345 p
Avail: NTIS HC/MF A15

This is the Federal Aviation Administrations (FAA) first annual aviation system capital investment plan (CIP). The CIP describes the policies and strategies that the FAA will pursue in addressing key concerns of the National Airspace System (NAS). The plan addresses safety, efficiency, traffic demands, aging equipment and facilities, and airspace use. It creates a foundation for evolution of the existing NAS through use of new technologies and development of new products obtained from continuing research. The following topics are covered: (1) a summary of the overall plan; (2) remaining original NAS plan projects; (3) requirements that expand, relocate, or consolidate existing facilities/equipment; (4) projects that refurbish structures, replace obsolete equipment, or relocate facilities to maintain service, improve effectiveness, or reduce cost; (5) projects that support logistics, provide for personnel training, and manage the information and human resource aspects of NAS modernization; and (6) new projects which, if implemented, are expected to add significant new capabilities to the NAS. Author

**N91-20068#** Computer Technology Associates, Inc., McKee City, NJ.
**CODEC TEST PLAN, PHASE 3**
Mark Grable Sep. 1990 46 p
(Contract DTFA03-89-C-00023)
(AD-A230395; DOT/FAA/CT-TN90/16-Phase-3) Avail: NTIS HC/MF A03 CSCL 25/2

The Federal Aviation Administration (FAA) Coder/Decoder (CODEC) Test Program will determine the suitability of low data rate digitized voice via a satellite link for air traffic control (ATC) applications. A primary concern of the FAA in assessing low data rate CODECs will be to minimize satellite bandwidth and power requirements while achieving acceptable voice performance. The final results of the FAA CODEC test plan will be analyzed and a recommendation of a low data rate voice CODEC for ATC communications will be proposed for inclusion to the Aeronautical Mobile Satellite Service (AMSS). The FAA CODEC testing will support the validation of Standards and Recommended Practices (SARPS), prepared by the International Civil Aviation Organization (ICAO), as well as Minimal Operational Performance Standards (MOPS), developed by the Radio Technical Commission for Aeronautics (RTCA), for AMSS voice communications. GRA

**N91-20069#** Federal Aviation Administration, Washington, DC. Office of Safety Oversight.
**AUTOMATIC BAROMETRIC UPDATES FROM GROUND-BASED NAVIGATIONAL AIDS Final Report**
W. J. Cox, Carol Simpson, and W. C. Connor 12 Mar. 1990 46 p
(AD-A230508; DOT/FAA/AOV-90-2) Avail: NTIS HC/MF A03 CSCL 01/4

This study examined techniques for transmitting automatic barometric updates of altimeter settings to pilots from ground-based navigation aids. It also examined the human factors and operational impact of providing automatic altimeter updates to flight crewmembers. The study considered the altimeter setting procedures of general aviation aircraft pilots operating in compliance with the Visual Flight Rules. And, it considered the altimeter setting procedures of pilots operating within the Instrument Flight Rules requirements. The study concludes that there are no insurmountable human factors or operational problems associated with the implementation of ABU, if the technique is based on automatic transmission of the barometric data through synthesized or digitized voice updates from the selected navigation aids. The study also concluded there is potential for improvement of aviation safety by implementing ABU techniques. These improvements would be in the form of: (1) enhancement of the quality of altimeter setting data used by VFR flight crewmembers operating below 18,000 feet MSL, (2) a reduction of workload for flight crewmembers of operating in either VFR or IFR environments, (3) a reduction of air traffic controller workload, and, (4) a small, but positive, reduction of traffic on ATC communication channels. GRA

**N91-20070#** Department of the Navy, Washington, DC.
**ALL-WEATHER APPROACH AND LANDING GUIDANCE SYSTEM USING PASSIVE DIHEDRAL REFLECTORS Patent Application**

Gerald E. Hart, inventor (to Navy) 24 Jul. 1990 52 p
(AD-D014749; US-Patent-Appl-SN-556606) Avail: NTIS HC/MF A04 CSCL 17/7

An all-weather aircraft landing system includes a plurality of ground based passive 90 deg dihedral reflectors for producing two-bounce reflected signals without ground reflections, and an airborne radar system which may transmit and receive 'same sense' circularly polarized radiation, while completely rejecting 'opposite sense' polarization returns or else using them to indicate weather conditions. Radar clutter from objects such as rain, building and trees which produce opposite sense reflections are rejected by the 'same sense' receiver or switched to an 'opposite sense' receiver to provide weather/obstacle condition information. By properly orienting a plurality of 90 deg dihedral angle reflectors of a particular size in a predetermined array pattern and tilt-angle adjacent a runway, the reflections from airborne radar signals are processed and displayed to provide a visual means for determining glide slope deviation and approach vector of the landing aircraft. In a preferred embodiment, two (portable) reflectors are used in conjunction with a conventional linearly polarized wave airborne radar system (e.g., standard modern weather radar), requiring no modifications to the airborne equipment while still providing an inexpensive means to obtain precise visual indication of glide slope and approach vector information. GRA

# 05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

For related information see also *18 Spacecraft Design, Testing and Performance* and *39 Structural Mechanics*.For land transportation vehicles see *85 Urban Technology and Transportation.*

**N91-20071*#** National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
**PROCEEDINGS OF THE X-15 FIRST FLIGHT 30TH ANNIVERSARY CELEBRATION**
Washington Jan. 1991 174 p Symposium held in Edwards, CA, 8 Jun. 1989
(NASA-CP-3105; H-1622; NAS 1.55:3105) Avail: NTIS HC/MF A08 CSCL 01C

A technical symposium and pilot's panel discussion were held on June 8, 1989, to commemorate the 30th anniversary of the first free flight of the X-15 rocket-powered research aircraft. The symposium featured technical presentations by former key government and industry participants in the advocacy, design, manufacturing, and flight research program activities. The X-15's technical contributions to the X-30 are cited. The panel discussion participants included seven of the eight surviving research pilots who flew the X-15 experimental aircraft to world altitude and speed records which still stand. Pilot's remarks include descriptions of their most memorable X-15 flight experience. The report also includes a historical perspective of the X-15. For individual titles, see N91-20072 through N91-20077.

**N91-20072*#** National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
**X-15 CONCEPT EVOLUTION**
Walter C. Williams *In its* Proceedings of the X-15 First Flight 30th Anniversary Celebration Jan. 1991 p 11-26 (For primary document see N91-20071 12-05)
Avail: NTIS HC/MF A08 CSCL 01C

The historical events that led to the development of the X-15 research aircraft are presented. Some of the topics presented include: (1) manned airplane performance regions; (2) X-15 flight problems; (3) design characteristics for conceptual aircraft; (4) analysis of X-15 accident potential; (5) X-15 performance requirements; and (6) milestones in the development of the X-15. K.S.

**N91-20073*#** National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
**X-15 HARDWARE DESIGN CHALLENGES**
Harrison A. Storms, Jr. *In its* Proceedings of the X-15 First Flight 30th Anniversary Celebration Jan. 1991 p 27-53 (For primary document see N91-20071 12-05)
Avail: NTIS HC/MF A08 CSCL 01C

Historical events in the development of the X-15 hardware design are presented. Some of the topics covered include: (1) drivers that led to the development of the X-15; (2) X-15 space research objectives; (3) original performance targets; (4) the X-15 typical mission; (5) X-15 dimensions and weight; (5) the propulsion system; (6) X-15 development milestones; (7) engineering and manufacturing challenges; (8) the X-15 structure; (9) ballistic flight control; (10) landing gear; (11) nose gear; and (12) an X-15 program recap. K.S.

**N91-20074*#** National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
**X-15: THE PERSPECTIVE OF HISTORY**
Richard P. Hallion *In its* Proceedings of the X-15 First Flight 30th Anniversary Celebration Jan. 1991 p 54-93 (For primary document see N91-20071 12-05)
Avail: NTIS HC/MF A08 CSCL 01C

The linkages between the Apollo 11 voyage to Tranquility Base and the 199 flights of the X-15 aircraft are discussed. Accomplishments of the X-15 program and a history of aircraft developments that led up to the X-15 are presented. K.S.

**N91-20075*#** National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
**THE LEGACY OF THE X-15**
Charles J. Donlan *In its* Proceedings of the X-15 First Flight 30th Anniversary Celebration Jan. 1991 p 94-102 (For primary document see N91-20071 12-05)
Avail: NTIS HC/MF A08 CSCL 01C

The X-15 established such widespread confidence in aerodynamic, thermal, and structural areas that new designs for operation aircraft for any speed regime could be expected to be successfully achieved if good use was made of all pertinent test facilities and analytical methods. This philosophy guided design of the space shuttle and is the real legacy of the X-15. The accomplishments and contributions attributable to the research and development work on the X-15 that influenced the formative years of the Space Shuttle Program are presented. Author

**N91-20076*#** National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
**X-15 CONTRIBUTIONS TO THE X-30**
Robert G. Hoey *In its* Proceedings of the X-15 First Flight 30th Anniversary Celebration Jan. 1991 p 103-121 (For primary document see N91-20071 12-05)
Avail: NTIS HC/MF A08 CSCL 01C

Some of the less publicized flight test results from the X-15 program that might relate to sustained high-speed flight in the atmosphere are presented. The topics covered include: (1) energy management and range considerations; (2) the advantages of pilot-in-the-loop and redundant-emergency systems; (3) a summary of some of the aerodynamic heating problems that were encountered; and (4) some comments on the advantages of an early flight test program and gradual expansion of the flight envelope. Author

**N91-20077*#** National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
**WHAT IS THE X-30**
Stephen D. Ishmael *In its* Proceedings of the X-15 First Flight 30th Anniversary Celebration Jan. 1991 p 122-138 (For primary document see N91-20071 12-05)
Avail: NTIS HC/MF A08 CSCL 01C

The X-30 is envisioned to be a machine that is capable of exploring technology that is critical to single stage to orbit and to hypersonic cruise. The X-30 is comparable to a laboratory that

will be able to investigate such things as the chemistry of supersonic combustion and the control of an of an integrated engine airframe, where the forebody of the airplane is the first compression surface for the propulsion. The X-30 is very ambitionous; it follows a path that is pretty well established by such programs as the X-15. This document is limited to a discussion of what is anticipated in the flight tests of the X-30 as opposed to describing the entire vehicle. Author

**N91-20078#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**BRIGHTNESS INVARIANT PORT RECOGNITION FOR ROBOTIC AIRCRAFT REFUELING M.S. Thesis**
Richard A. Bennett 13 Dec. 1990 90 p
(AD-A230468; AFIT/GE/ENG/90D-04) Avail: NTIS HC/MF A05 CSCL 01/2

The purpose of this thesis effort was to develop and test a brightness invariant recognition algorithm that would locate and identify the half-scale mock up of a Universal Aerial Refueling Receptacle Slipway Installation (UARRSI) aerial refueling port in different lighting conditions. This was accomplished by developing a brightness invariant port recognition of identifiable attributes of the refueling port to locate and identify the UARRSI port. Based on this approach, a brightness invariant port recognition system (BIPRS) was demonstrated which identified the refueling receptacle in different lighting conditions. The BIPRS was also invariant to orientation and size of the UARRSI port. The BIPRS demonstrated the feasibility of the autonomous aircraft refueling task, and provides an incentive for additional research in autonomous robot applications. GRA

**N91-20079#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**DYNAMIC ANALYSIS OF A COMBAT AIRCRAFT WITH CONTROL SURFACE FAILURE M.S. Thesis**
Marc Roy Nov. 1990 133 p
(AD-A230517; AFIT/GAE/ENY/90D-24) Avail: NTIS HC/MF A07 CSCL 01/1

An investigation was performed to analyze the dynamic stability characteristic of an aircraft which has sustained damage to a primary control surface. The analysis was performed using the existing functional form of actual wind tunnel data taken on an F-16 model. Two control schemes are used for trimming an F-16 that has sustained damage to its rudder. The first control scheme represent the basic aircraft, while the second allowed the horizontal tail ailerons to move independently from the flaperons. The investigation was conducted for one flight condition representative of the aircraft at cruise speed. Region in alpha/beta (angle of attack)/(sideslip angle) space where trim can be achieved was selected as input into a linearized aircraft model. This model took into account the failed control surface. Eigenvalues of the open and closed loop models were analyzed to determine the region in alpha/beta space where the aircraft was dynamically stable. Migration of the eigenvalues for several trim conditions was also investigated to gain insight on the aircraft behavior while in an unsymmetrical orientation. For this study, the open loop eigenvalues for the trim are investigated save a stable system. When the aircraft controller was added into the system, regions of dynamic instability appeared. For rudder failure less than 20 degrees, trim could be achieved but the aircraft was dynamically unstable. GRA

**N91-20080#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**THREE DEGREES OF FREEDOM COMPLIANT MOTION CONTROL FOR ROBOTIC AIRCRAFT REFUELING M.S. Thesis**
Clayton M. Andersen 13 Dec. 1990 93 p
(AD-A230581; AFIT/GAE/ENG/90D-01) Avail: NTIS HC/MF A05 CSCL 12/9

The Air Force Institute of Technology (AFIT) supports on-going research in application of robotic technology to enhance assembly tasks. As a testbed, AFIT supports the ground-based aerial refueling project, with an emphasis on visual servoing techniques and compliant motion control. This thesis focuses on compliant motion control. Previous research developed the testing environment, which includes a PUMA-560 industrial manipulator, and a half scale mock-up of an aerial refueling system. This effort corrected and expanded the existing two degree of freedom (DOF) compliant controller to three DOF. Three DOF compliance was demonstrated by inserting the refueling nozzle into the receiver port. Tuning, carried out by adjusting desired model variables, characterized the impedance controller to function over a wide range of desired dynamics. In addition, irregular force and velocity torque profiles were attenuated through basic filtering schemes, providing an environment in which friction compensation was tested. Finally, preliminary studies into faster trajectories provide impetus for further study in the area of high speed compliant assembly. The three DOF compliant controller combined with the visual servoing techniques, provides a strong environment to test and evaluate robotic technologies for constrained motion assembly tasks. GRA

**N91-20715*#** Ocean Systems Engineering, Inc., Falls Church, VA.
**CONSIDERATIONS FOR HUMAN-MACHINE INTERFACES IN TELE-OPERATIONS**
Curt Newport *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 561-568 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 05H

# 06 AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

For related information see also *19 Spacecraft Instrumentation* and *35 Instrumentation and Photography.*

**N91-20081#** Electronics Research Lab., Adelaide (Australia).
**LOGGING PROGRAMMES FOR TRIAL THUNDERSTOP**
Robert J. Rossiter Sep. 1990 35 p
(AD-A229854; ERL-0532-GD; DODA-AR-006-453) Avail: NTIS HC/MF A03 CSCL 09/3

The programs discussed were written in support of Trial 7/423 code-name THUNDERSTOP. The trial involved the testing of a laser warning receiver (LWR) against three different lasers. These lasers are: (1) a commercial range finder (SIMRAD); (2) a laser target designator (LTD); (3) a beam rider simulator (BRIS). There were two computer programs written. The first GSTN was written for the ground station logging system, and the second LWREC was written for the airborne logging system (mounted in a helicopter). GRA

**N91-20082#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**AN EVALUATION OF AN Ada IMPLEMENTATION OF THE RETE ALGORITHM FOR EMBEDDED FLIGHT PROCESSORS M.S. Thesis**
F. J. Fanning Dec. 1990 116 p
(AD-A230443; AFIT/GE/ENG/90D-70) Avail: NTIS HC/MF A06 CSCL 12/5

The purpose of this thesis was to design and develop an expert system shell in Ada, and to evaluate the shell's execution and size performance to determine its suitability for real-time operation on the MIL-STD-1750A embedded flight processor. The expert system shell uses the CLIPS/Ada inference engine, a forward-chaining Ada implementation of Rete. The expert system shell design is presented along with an overview of the target environment--the MIL-STD-1750A VHSIC Avionic Modular Processor (VAMP) running under the Ada Avionics Real-Time Software (AARTS) Operating System. Theoretical and empirical complexity analyses of the inference engine are presented and discussed in view of their impact on VAMP application. The performance of this inference engine was affected by five

parameters of the knowledge base: (1) the number of objects in working memory; (2) the structural complexity of the objects and rules; (3) the number of rules which share object match patterns; (4) the number of match patterns per rule, and (5) the number of objects bound to a match pattern. The inference engine's execution response time was found suitable for real-time operation on the VAMP; however, its memory requirement was not. GRA

**N91-20083#** Amptek, Inc., Bedford, MA.
**PROTOTYPE INSTRUMENTATION AND DESIGN STUDIES**
Alan C. Huber, John O. McGarity, John A. Pantazis, A. W. Everest, and David J. Sperry 14 May 1990 162 p
(Contract F19628-87-C-0094)
(AD-A230707; GL-TR-90-0132; SR-2) Avail: NTIS HC/MF A08 CSCL 20/9

Flight prototype sensor systems using spherical sections and electrostatic deflection are being developed, fabricated, tested and calibrated. The detectors will measure the flux of ions and electrons over a 100 x 10 degree angular fan and in 32 discrete energy levels from 10 eV to keV. This report describes the sensor system design for an instrument package for shuttle flight as well as a correlator to look for wave-particle interactions. GRA

# 07 AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxilliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion.*

**N91-20084*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**AN IMAGING SYSTEM FOR PLIF/MIE MEASUREMENTS FOR A COMBUSTING FLOW**
C. C. Wey, B. Ghorashi, C. J. Marek, and C. Wey (Sverdrup Technology, Inc., Brook Park, OH.) 1990 13 p Presented at the 6th International Symposium on Heat and Mass Transfer, Miami, FL, 10-12 Dec. 1990; sponsored by Miami Univ.
(Contract NAS3-25266)
(NASA-TM-103714; E-5887; NAS 1.15:103714) Avail: NTIS HC/MF A03 CSCL 21E

The equipment required to establish an imaging system can be divided into four parts: (1) the light source and beam shaping optics; (2) camera and recording; (3) image acquisition and processing; and (4) computer and output systems. A pulsed, Nd:YAG-pummped, frequency-doubled dye laser which can freeze motion in the flowfield is used for an illumination source. A set of lenses is used to form the laser beam into a sheet. The induced fluorescence is collected by an UV-enhanced lens and passes through an UV-enhanced microchannel plate intensifier which is optically coupled to a gated solid state CCD camera. The output of the camera is simultaneously displayed on a monitor and recorded on either a laser videodisc set of a Super VHS VCR. This videodisc set is controlled by a minicomputer via a connection to the RS-232C interface terminals. The imaging system is connected to the host computer by a bus repeater and can be multiplexed between four video input sources. Sample images from a planar shear layer experiment are presented to show the processing capability of the imaging system with the host computer. Author

**N91-20085*#** San Jose State Univ., San Francisco, CA.
**THE EFFECTS OF COMPRESSOR SEVENTH-STAGE BLEED AIR EXTRACTION ON PERFORMANCE OF THE F100-PW-220 AFTERBURNING TURBOFAN ENGINE Final Report**
Alison B. Evans Feb. 1991 29 p
(NASA Order SA-25821)
(NASA-CR-179447; H-1679; NAS 1.26:179447) Avail: NTIS HC/MF A03 CSCL 21E

A study was conducted to determine the effects of seventh-stage compressor bleed on the performance of the F100 afterburning turbofan engine. The effects of bleed on thrust, specific fuel consumption, fan turbine inlet temperature, bleed total pressure, and bleed total temperature were obtained from the engine manufacturer's status deck computer simulation. These effects were determined for power settings of intermediate, partial afterburning, and maximum afterburning for Mach numbers between 0.6 and 2.2 and for altitudes of 30,000, 40,000, and 50,000 ft. It was found that thrust loss and specific fuel consumption increase were approximately linear functions of bleed flow and, based on a percent-thrust change basis, were approximately independent of power setting. Author

**N91-20086*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**AEROPROPULSION 1991**
Mar. 1991 574 p Conference held in Cleveland, OH, 20-21 Mar. 1991
(NASA-CP-10063; E-5954; NAS 1.55:10063) Avail: NTIS HC/MF A24 CSCL 21E

For the 50th anniversary, a review was provided of recent accomplishments of the ongoing programs at Lewis Research Center. The Lewis Aeropropulsion Program has the charter to develop advanced airbreathing propulsion technology for applications of national interest. To implement this program, Lewis concentrates its basic research in the critical disciplines of internal fluid mechanics, instrumentation and control, and structures and materials. The efforts are focused on developing new science, often implemented through advanced computer codes. Carefully designed experiments provide the data required to validate the advanced codes. Recent results and planned accomplishments in these areas are reviewed. From this firm foundation technology is investigated for a number of applications including propulsion, high performance and hypersonic aircraft, rotorcraft, and general aviation. For individual titles, see N91-20087 through N91-20121.

**N91-20087*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**LEWIS AEROPROPULSION TECHNOLOGY: REMEMBERING THE PAST AND CHALLENGING THE FUTURE** **c99**
Neal T. Saunders and Arthur J. Glassman *In its* Aeropropulsion 1991 Mar. 1991 21 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 05D

It was on January 23, 1941, less than two years after the first flight of a jet-propelled aircraft, that ground was broken in Cleveland for the NACA Aircraft Engine Research Laboratory (AERL). Originally envisioned as a laboratory for fundamental research on piston engines, the new NACA laboratory never actually fulfilled this role. From the first test in 1942 until the end of the war in 1945, primary emphasis was on trouble-shooting to solve the problems of engines in production for the war effort. By the end of the war, the transition from piston to jet propulsion was well underway, and with it went the direction of the laboratory's program. Some of the major accomplishments over the past fifty years are reviewed and the challenges of the future examined. From piston engines through environmentally acceptable high-speed propulsion systems, efforts have included and will continue to include discipline, component, and engine activities along with provision of facilities to carry out the programs. Author

**N91-20088*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**OVERVIEW OF SUPERSONIC CRUISE PROPULSION RESEARCH**
R. J. Shaw *In its* Aeropropulsion 1991 Mar. 1991 30 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 21E

Significant advances in propulsion performance are required if supersonic transport vehicles are to become an important part of the 21st century international air transportation system. The objective of the NASA Lewis Supersonic Cruise propulsion research

is to provide the critical propulsion technologies to the industry in a timely fashion to contribute to the design of economically viable and environmentally acceptable high-speed civil transport (HSCT). Author

**N91-20089*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**OVERVIEW OF HIGH PERFORMANCE AIRCRAFT PROPULSION**
Peter G. Batterton and Thomas J. Biesiadny *In its* Aeropropulsion 1991 Mar. 1991 18 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 21E

The basic overall scope of the Lewis High Performance Aircraft Propulsion Research and Technology effort is presented. High performance fighter aircraft of interest include supersonic fighters with such capabilities as short take off and vertical landing (STOVL) and/or high maneuverability. The effort is primarily focused on component-level experimental and analytical research. This research is designed to provide databases for verification of design technology and for calibration of the CFD tools available for design use. Examples from each of the research areas are discussed, and a brief look at future directions for high performance aircraft research and technology is presented. Author

**N91-20090*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**FLOW VISUALIZATION AND HOT GAS INGESTION CHARACTERISTICS OF A VECTORED THRUST STOVL CONCEPT**
Albert L. Johns, George H. Neiner, Timothy J. Bencic, David M. Fricker, and Jerome T. Kegelman (McDonnell-Douglas Research Labs., Saint Louis, MO.) *In its* Aeropropulsion 1991 Mar. 1991 17 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 21E

Hot gas ingestion, the entrainment of heated engine exhaust into the inlet flow field, is the key development issue for advanced short takeoff and vertical landing aircraft. A 9.2 percent scale short takeoff and vertical landing (STOVL) hot gas ingestion model was designed and built by McDonnell Douglas Corporation (MCAIR) and tested in the NASA Lewis Research Center 9 by 15 foot Low Speed Wind Tunnel (LSWT). The test was conducted over a range of headwind velocities from 10 to 23 kn and nozzle exhaust temperatures from 500 to 1000 F. The model was also tested over a range of model heights above the ground plane (0.20 to 12 in.) and a range of nozzle pressure ratios from 1.3 to 4.00. A copper vapor laser was used to create an illuminated flow field for flow visualization with the model in and out of ground effects. Results are presented showing the flow field visualization which occurs when the model was in and out of ground effects. The effect of hot gas ingestion on the compressor face temperature rise and several other parameters are also presented. The environmental effects of the hot gas on the ground and its effect on the acoustic loads as a function of the model height above the ground are also presented. Author

**N91-20091*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**HIGH ALPHA INLETS**
Richard R. Burley, Bernhard H. Anderson, C. Frederic Smith, and Gary J. Harloff (Sverdrup Technology, Inc., Cleveland, OH.) *In its* Aeropropulsion 1991 Mar. 1991 14 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 21E

The high alpha inlet research effort at Lewis is part of the High Alpha Technology Program (HATP) within NASA. A key goal of HATP is to develop concepts that provide a high level of control and maneuverability for high performance aircraft at low subsonic speeds and angles-of-attack above 60 degrees. The approach, which consists of both experimental and computational efforts, utilizes the F-18 High Alpha Research Vehicle (HARV) as well as subscale models to obtain the experimental data base needed for validation of the computational codes. As the propulsion center within NASA, the overall objectives of the Lewis effort is to develop and enhance inlet technology that will ensure high performance and stability of the propulsion system during the aircraft maneuvers at low speeds and high angles-of-attack. An overview is presented of the existing Lewis technology for achieving high inlet performance at low subsonic speed/high angle-of-attack conditions and the plans to extend this technology to advanced, highly maneuverable aircraft. The discussion is divided into six parts: the scope of the HATP effort; the inlet challenge for highly maneuverable aircraft, the Lewis data base, the Lewis computational effort, future plans, and concluding remarks. Author

**N91-20092*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**OVERVIEW OF HYPERSONIC/TRANSATMOSPHERIC VEHICLE PROPULSION TECHNOLOGY**
John E. Rohde *In its* Aeropropulsion 1991 Mar. 1991 11 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 21E

Significant progress is being made in attaining many of the enabling technologies critical to the development of future hypersonic vehicles such as the single-stage-to-orbit National Aerospace Plane (NASP) X-30 vehicle and others. In the NASP program, slush hydrogen was safely produced and transferred in modestly large quantities. Inlet testing has demonstrated that a high-performance configuration can be developed, and configurations were developed that reduce cross-talk between engine modules and improve unstart margins. Tests of a hydrogen-fueled ramjet engine model were conducted to investigate engine operability and dynamics, and future tests are planned to demonstrate a closed-loop engine control system. Nozzle tests have identified large transonic-drag losses in the nozzle, which were then reduced significantly through the use of external burning. In other research areas, such as engine seals, advanced materials, and para-to-ortho hydrogen conversion, promising concepts were identified and continuing efforts are adding to these technologies. In the General Hypersonics program an improved understanding is being gained of the physics of inlets, combustors, and nozzles and are developing advanced materials and computational codes that predict the characteristics of both reacting flows and metal matrix composites structures. The High-Mach Turbine-Engine (HiMaTE) component technology program has identified the turboramjet and the air-turboramjet as the most promising combined-cycle engines for more detailed assessment. Efforts are continuing to define critical components for development and testing to demonstrate technology readiness and to establish cycle feasibility. Studies are being conducted to assess the potential benefit of using these combined-cycle engines to power the first stage of two-stage-to-orbit (TSTO) vehicles and other hypersonic vehicles. Author

**N91-20093*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**OVERVIEW OF NASP NOZZLE RESEARCH**
Charles J. Trefny, Rickey J. Shyne, and Jeanne D. Carboni *In its* Aeropropulsion 1991 Mar. 1991 16 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 21E

Problems facing the National Aerospace Plane (NASP) nozzle at transonic and low supersonic conditions are discussed. An overview of NASP nozzle research at Lewis Research Center is given. Experimental facilities and computational techniques currently in use are reviewed. External burning as a means to reduce transonic drag and initial results of external burning experiments are discussed. Author

**N91-20094*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**A COMPARISON OF CFD PREDICTIONS AND EXPERIMENTAL RESULTS FOR A MACH 5 INLET**
Lois J. Weir and D. R. Reddy *In its* Aeropropulsion 1991 Mar.

1991 16 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 21E

Flow through a high-speed, nominally two-dimensional inlet is characterized by highly complex, three-dimensional flow phenomena including strong secondary flows and shock/boundary layer interactions. Experimental and analytical data are presented for a Mach 5 mixed compression inlet that exhibits such three-dimensional flow characteristics. The two-dimensional inlet model, designed to provide performance information in the Mach 3 to 5 speed range for an over-under turbojet plus ramjet propulsion system, was also instrumented to provide computational fluid dynamic (CFD) code calibration and validation data, and, in particular, to provide some detailed data in regions where three-dimensional phenomena dominate the local flow field. Calculations of the inlet flow field presented include three-dimensional parabolized and full Navier-Stokes code analyses, with and without bleed. The CFD analyses predicted flow migration up the inlet sidewalls due to glancing shock/boundary layer interactions, which, in turn, developed patterns of vortical flow in the inlet. This vortical flow was at least partially captured by the cowl, which set up large regions of low-energy flow in the corners underneath the cowl. As the vortical flow stream passed through the strong cowl shock, its vorticity appeared to be somewhat dissipated and the low-energy flow was compressed against the cowl. Comparisons between analytical predictions and experimental results are presented for rakes located in regions of vortical flow, separation, or both in the corners between the cowl and the sidewalls. Both experimental and analytical results indicated that porous bleed upstream on the inlet sidewalls and in the corners of the cowl had little effect on the vortical flow entering the inlet; however, bleed removed farther downstream near the shoulder (after the rotational flow had passed through the cowl shock) appeared to remove the low-energy flow on the cowl and sidewalls rather effectively. Author

**N91-20095*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**INTERNAL FLUID MECHANICS RESEARCH** **c34**
Lonnie Reid and Louis A. Povinelli *In its* Aeropropulsion 1991 Mar. 1991 3 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 20D

The Internal Fluid Mechanics Division is responsible for computational and experimental research on the internal aerothermodynamics of aeronautical and space propulsion systems. The research focuses on advancing the understanding of the relevant physics associated with improving the state of technology for propulsion system components. Research consists of the development of fast and accurate computational tools and models, the verification of these CFD tools and models through benchmark experiments, and their application to realistic propulsion system components. Advanced computational technologies are used to enhance, accelerate, and integrate computational and experimental research. The presentations summarize ongoing work and indicate emphasis in three major research thrusts, namely, inlets, ducts, and nozzles; turbomachinery; and chemical reacting flows. Author

**N91-20096*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**INLETS, DUCTS, AND NOZZLES** **c34**
James R. Scott and John M. Abbott *In its* Aeropropulsion 1991 Mar. 1991 27 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 20D

The internal fluid mechanics research program in inlets, ducts, and nozzles is a balanced effort between the development and application of computational tools and the conduct of experimental research. The computational effort involves the development and validation of advanced computational fluid dynamics (CFD) codes through comparison with data, the modification of existing codes to extend their range and accuracy, and the application of codes to practical problems to demonstrate their value in design. The experimental research involves both simplified and realistic complex geometries and is used for developing flow physics understanding, for validating advanced numerical analysis codes, and for developing physical models of flow phenomena. The inlet, duct, and nozzle research program is described according to three major classifications of flow phenomena: highly three-dimensional flow fields; shock and high-speed-mixing flow fields; and shear flow control. Specific examples of current and future elements of the research program are described for each of these phenomena. In particular, the highly three-dimensional flow field phenomenon is highlighted by describing the experimental and computational research program in transition ducts having a round-to-rectangular area variation. In the case of shock and high-speed-mixing flow fields, both experimental and computational results are presented for the mixing of a high-speed stream injected into a second high-speed stream. For shear flow control, research in the use of aerodynamic excitation to enhance the jet mixing process is described. In addition, results that stem from using small tabs protruding into a nozzle exit flow stream to enhance mixing are also presented. A three-dimensional, unsteady viscous code development effort that will provide a well-documented, user-friendly flow solver for computing inlet, duct, and nozzle flow fields in the future is described. Author

**N91-20097*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**TURBOMACHINERY** **c34**
Anthony J. Strazisar, Raymond E. Gaugler, John J. Adamczyk, Dale J. Arpasi, and Isaac Lopez (Army Aviation Systems Command, Cleveland, OH.) *In its* Aeropropulsion 1991 Mar. 1991 8 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 20D

Over the last few years a dramatic rise was seen in the capability to computer the 3D flow in turbomachinery, and a program was developed where experimental and computational efforts were applied synergistically to maximize the understanding of the complex flows existing in turbomachinery passages. This improved capability and understanding will lead to significantly better turbomachine designs in the future. Author

**N91-20098*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**CHEMICAL REACTING FLOWS** **c34**
Erwin A. Lezberg, Edward J. Mularz (Army Aviation Systems Command, Cleveland, OH.), and Meng-Sing Liou *In its* Aeropropulsion 1991 Mar. 1991 26 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 20D

The objectives and accomplishments of research in chemical reacting flows, including both experimental and computational problems are described. The experimental research emphasizes the acquisition of reliable reacting-flow data for code validation, the development of chemical kinetics mechanisms, and the understanding of two-phase flow dynamics. Typical results from two nonreacting spray studies are presented. The computational fluid dynamics (CFD) research emphasizes the development of efficient and accurate algorithms and codes, as well as validation of methods and modeling (turbulence and kinetics) for reacting flows. Major developments of the RPLUS code and its application to mixing concepts, the General Electric combustor, and the Government baseline engine for the National Aerospace Plane are detailed. Finally, the turbulence research in the newly established Center for Modeling of Turbulence and Transition (CMOTT) is described. Author

**N91-20099*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**INSTRUMENTATION AND CONTROLS OVERVIEW** **c09**
Norman C. Wenger *In its* Aeropropulsion 1991 Mar. 1991 8 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 14B

The Lewis Research Center has had a long history of research directed toward advancing the Nation's capability in the areas of propulsion research instrumentation and propulsion controls. Some

of the major advances from this research are highlighted as well as some of the planned research that will strongly impact the future capabilities. Efforts on research instrumentation and controls, as well as, efforts in high-temperature electronics are covered. The goals, scope, and major thrusts in each of the research areas are stressed. Author

**N91-20100*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**PROPULSION INSTRUMENTATION RESEARCH c35**
William C. Nieberding, Daniel J. Lesco, and W. Dan Williams *In its* Aeropropulsion 1991 Mar. 1991 21 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 14B

As was stated in the overview, the goal of the Propulsion Instrumentation Research Program is to provide the instrumentation technology advances needed to support future aeropropulsion research and development. A hallmark of this work is that the sensors and measurement systems being developed are not intended to be used on operational propulsion systems. The systems are aimed at experiments for engine development, component development, and analytical code validation. Although sensors and/or systems for operational engines sometimes grow out of this work, they are not the goal. A further characteristic of this work is that it is frequently blind about whether the application is for aero or space propulsion. Some of the following examples are currently being developed for space propulsion systems, but they are also applicable to aeropropulsion. Author

**N91-20101*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**HIGH TEMPERATURE ELECTRONICS c33**
Gary T. Seng *In its* Aeropropulsion 1991 Mar. 1991 13 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 09C

In recent years, the aerospace propulsion and space power communities have acknowledged a growing need for electronic devices that are capable of sustained high-temperature operation. Aeropropulsion applications for high-temperature electronic devices include engine ground test instrumentation such as multiplexers, analog-to-digital converters, and telemetry systems capable of withstanding hot section engine temperatures in excess of 600 C. Uncooled operation of control and condition monitoring systems in advanced supersonic aircraft would subject the electronics to temperatures in excess of 300 C. Similarly, engine-mounted integrated electronic sensors could reach temperatures which exceed 500 C. In addition to aeronautics, there are many other areas that could benefit from the existence of high-temperature electronic devices. Space applications include power electronic devices for space platforms and satellites. Since power electronics require radiators to shed waste heat, electronic devices that operate at higher temperatures would allow a reduction in radiator size. Terrestrial applications include deep-well drilling instrumentation, high power electronics, and nuclear reactor instrumentation and control. To meet the needs of the applications mentioned previously, the high-temperature electronics (HTE) program at the Lewis Research Center is developing silicon carbide (SiC) as a high-temperature semiconductor material. Research is focused on developing the crystal growth, growth modeling, characterization, and device fabrication technologies necessary to produce a family of SiC devices. Interest in SiC has grown dramatically in recent years due to solid advances in the technology. Much research remains to be performed, but SiC appears ready to emerge as a useful semiconductor material. Author

**N91-20102*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**FIBER-OPTIC-BASED CONTROLS c74**
Gary T. Seng *In its* Aeropropulsion 1991 Mar. 1991 11 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 20F

The challenge of those involved in control-system hardware development is to accommodate an ever-increasing complexity in aircraft control, while limiting the size and weight of the components and improving system reliability. A technology that displays promise towards this end is the area of fiber optics. The primary advantages of employing optical fibers, passive optical sensors, and optically controlled actuators over conventional control systems are greater immunity from electromagnetic effects, weight and volume reduction, non-radiating characteristics, superior bandwidth capabilities, and freedom from short circuits and sparking contacts. Since 1975, NASA Lewis has been performing in-house, contract, and grant research in fiber-optic sensors, high-temperature electro-optic switches, and fly-by-light control system architecture. Passive optical sensor development is an essential yet challenging area of work and has therefore received much attention during this period. A major effort to develop and demonstrate fly-by-light control system technology, known as the fiber optic control system integration (FOCSI) program, was initiated in 1985. Phase 1 of FOCSI, A NASA-DOD effort completed in 1986, was aimed at the design of a fiber optic propulsion/flight control system. Phase 2, a NASA Navy effort currently in progress, will provide the system design, subcomponent and system development, and system ground tests. Phase 3, flight demonstration, was also initiated and will culminate in full FOCSI system flight tests. In addition to a summary of the benefits of fiber optics, the FOCSI program, sensor advances, and future directions in the NASA Lewis program are discussed. Author

**N91-20103*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**ADVANCED AEROPROPULSION CONTROLS TECHNOLOGY**
Carl F. Lorenzo *In its* Aeropropulsion 1991 Mar. 1991 25 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 21E

The NASA Lewis research activities in the area of propulsion control as driven by the trends and needs of advanced aircraft are discussed. Special emphasis is placed on research to develop design methodologies for integrated flight and propulsion control. Research thrusts in hypersonic propulsion control and dynamics in support of the National Aerospace Plane are also covered, and a new concept for system critical component life-extending control is discussed. Author

**N91-20104*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**OVERVIEW OF STRUCTURES RESEARCH c39**
Larry D. Pinson *In its* Aeropropulsion 1991 Mar. 1991 9 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 20K

The development of aeronautical and space propulsion systems structures technology is the mission of the Structures Division. The technology required to achieve reliable, high-performance, lightweight structures needed for aerospace propulsion is among the most complex and challenging facing the design engineer. The division staff performs both fundamental and applied research in structural mechanics, fatigue and fracture, structural dynamics, and structural integrity. Research programs include probabilistic analysis and design, nonlinear material properties, symbolic logic, composite micromechanics, aeroelasticity, fatigue and fracture of composite structures, life prediction, and aspects of nondestructive evaluation. These programs, which for the most part are analytically based, are experimentally verified and are used to develop computer codes necessary for the design of complex engine structures. An overview of some of these programs is presented. Author

**N91-20105*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**PROPULSION AEROELASTICITY, VIBRATION CONTROL, AND DYNAMIC SYSTEM MODELING**
Bruce M. Steinetz *In its* Aeropropulsion 1991 Mar. 1991 11 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 21E

Aeropropulsion research in the Structural Dynamics Branch of Lewis Research Center is aimed at addressing two key objectives:

(1) conceiving and implementing innovative structural concepts to enhance the performance of advanced aeropropulsion systems; and (2) developing and validating analytical techniques to define the limits of dynamic performance of advanced aeroengines, prior to costly full-scale testing. Aeroelasticity, vibration control, and dynamic systems are the three research areas that make up the Structural Dynamics Branch. In the aeroelasticity technical area, researchers use both analytical and experimental means to extend and define the structural performance limits of advanced propulsion systems, including future ultra-high-bypass ducted turbofans, advanced turboprops, and high power-density turbopumps. Vibration control researchers are developing and evaluating active control systems and the required high-speed robust electronic controls to minimize unwanted shaft vibration of both turbine-engines and rocket engine turbopumps. Researchers in the dynamic systems technical area are developing a new class of high-temperature dynamic engine seals required for advanced hypersonic (e.g., National Aerospace Plane) engines, as well as developing advanced space mechanism technology to enable future space missions. Central to each of the branch's technical areas is the development of advanced computational methods which, with the aid of modern computer science, will fundamentally improve solution speed and accuracy of large scale structural dynamics problems. Author

**N91-20106*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**COMPUTATIONAL SIMULATION OF PROPULSION STRUCTURES PERFORMANCE AND RELIABILITY**

Dale A. Hopkins *In its* Aeropropulsion 1991 Mar. 1991 10 p (For primary document see N91-20086 12-07)

Avail: NTIS HC/MF A24 CSCL 21E

The chronicle of aeropropulsion development reveals a deliberate evolution during which new engine designs have been derived by incremental improvements of successful previous systems. Aerospace vehicles envisioned near the turn of the century and beyond demand advances in propulsion systems of more revolutionary than evolutionary significance. The systems of tomorrow require unprecedented levels of performance, durability, reliability, and operational economy. Achieving these requirements presents a significant challenge to develop enabling computational structures technology. The aim of computational structures technology is to transform the engine development process by empowering computational simulation to have the principle role. The arena of computation structures technology for aeropropulsion has produced some noteworthy recent gains, and even more extraordinary advances are still to be realized. The essential elements in this endeavor are the following: (1) fundamental theoretical models that more completely represent the complex physics governing engine structural performance; (2) computational techniques that provide accurate and efficient solutions of the governing models and which exploit the potential of emerging computer technology; and (3) integrated strategies for simulation that allow engine structural models of varying fidelity to be evaluated as a continuous and adaptive process. Author

**N91-20107*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**TRANSITION-TO-PRACTICE TECHNOLOGIES FOR BRITTLE MATERIALS** **c27**

Edward R. Generazio *In its* Aeropropulsion 1991 Mar. 1991 18 p (For primary document see N91-20086 12-07)

Avail: NTIS HC/MF A24 CSCL 11C

Four major technologies are needed to bring brittle ceramic composites up to the level necessary for practical application as aerospace materials. These are mechanical testing, nondestructive evaluation (NDE), mechanical design, and life prediction. An advanced design tool, C-CARES, was developed to assist designers in the mechanical design of structural ceramic components by determining the reliabilities of these components. In situ and in process NDE are being used to enhance/accelerate development of ceramic matrix composites (CMC's). As a very minimum both x-ray and ultrasonic imaging needs to be performed for an accurate NDE. In situ and in process NDE also provides validation of analytical models. Author

**N91-20108*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**PROGRESS IN MODELING DEFORMATION AND DAMAGE** **c39**

Alan D. Freed and Steven M. Arnold *In its* Aeropropulsion 1991 Mar. 1991 9 p (For primary document see N91-20086 12-07)

Avail: NTIS HC/MF A24 CSCL 20K

In hypersonic aircraft, for example, high temperature structures (such as leading edges, inlet cowls, combustor liners, and nozzles) are subjected to thermomechanical deformations. It is believed that such deformations will be a primary cause of structural failure in these components. They arise from large thermal gradients across structural skins that are constrained from free thermal expansion. In order to assess structural life and performance, the material's thermomechanical behavior must be incorporated into the structural design. The laboratories of the Fatigue and Fracture Branch of Lewis Research Center are dedicated to observing the evolution of deformation and damage in laboratory specimens under thermomechanical loading conditions. These observations are used within the branch to guide the development of deformation and life-assessing models. Author

**N91-20109*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**OVERVIEW OF LEWIS MATERIALS RESEARCH: CONTRIBUTIONS, CURRENT EFFORTS, AND FUTURE DIRECTIONS** **c26**

Salvatore J. Grisaffe and Carl E. Lowell *In its* Aeropropulsion 1991 Mar. 1991 20 p (For primary document see N91-20086 12-07)

Avail: NTIS HC/MF A24 CSCL 11F

In the 1940's, materials research efforts on high-temperature valve alloys at NASA Lewis Research Center led to the improved lives and performance of piston-engined fighter and bomber aircraft. The metallurgical skills acquired from that work were then applied to the formulation of high-temperature turbine blade alloys for aircraft gas turbine engines developed in the 1950's. Today, the benefits of superior U.S. engine technology have never been clearer for both commercial and military aircraft. Yet, these superior engines of the 1980's and 1990's now use some the the materials that we helped conceive and evolve in the 1960's and 1970's. NASA Lewis is currently charged with helping industry create, advance, and develop the materials for 21st century engines: 2005 to 2015 plus. Highlights of past work, staff, and facilities are presented. The challenges and new material and process concepts that are currently being worked on as well as plans for the future are summarized. Author

**N91-20110*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**ADVANCED HIGH TEMPERATURE ENGINE MATERIALS TECHNOLOGY PROGRAM** **c24**

Hugh R. Gray *In its* Aeropropulsion 1991 Mar. 1991 28 p (For primary document see N91-20086 12-07)

Avail: NTIS HC/MF A24 CSCL 11D

NASA's Advanced High Temperature Engine Materials Technology Program (HITEMP) is directed towards generating the technology for revolutionary advances in structural materials and analysis to enable the development of 21st century civil aeronautics propulsion systems. Major consideration is being given to propulsion systems that will be economical via reducing fuel consumption per passenger mile, reducing direct operating costs, extending life, and improving reliability. To achieve revolutionary advances in propulsion systems for 21st century transports, high temperatures materials have been identified as the key technology to be addressed. The HITEMP Program is focusing on lightweight composite materials to gain revolutionary advances in the operating temperatures of advanced engines compared to the current state

of the art. Emphasis is placed on polymer matrix composites for potential use in fans, casings, and engine control systems. Intermetallic/metal matrix composites are under investigation for application in such areas as compressor and turbine disks, blades, and vanes and in the exhaust nozzle. For extremely high temperature applications, ceramic matrix composites are being explored. Initial applications may include liners for the combustor and exhaust nozzle, and turbine vanes and ultimately turbine blades and disks, or blisks. Author

**N91-20111*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**COMPUTATIONAL MATERIALS SCIENCE. AN EXAMPLE: NUMERICAL MODELING OF CHEMICAL VAPOR DEPOSITION PROCESSING OF ADVANCED FIBERS c24**
Arnon Chait, Suleyman Gokoglu, Maria Kuczmarski, Pang Tsui, Lisa Veitch, David Thompson, and Ronald Gaug (Akron Univ., OH.) *In its* Aeropropulsion 1991 Mar. 1991 16 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 11D

Computational materials science is a rapidly emerging discipline combining aspects from chemistry, fluid dynamics, and materials and computational sciences. The details of initial efforts undertaken in the Materials Division at Lewis Research Center are presented to establish a dedicated facility for numerical and analytical simulations of materials processing. Computation Materials Laboratory activities are currently aimed at understanding and optimizing processes involving transport of heat, fluid, and mass. An ongoing combined experimental and numerical study is presented. It illustrates the growth of advanced fibers for high-temperature composite applications by using dimensional heat and fluid flow inside the reactor along with simultaneous computations of the chemically reacting gas, and fiber surface species are shown to provide an enhanced level of understanding of the process. The difficulties in simulating the entire process, as well as the present accomplishments, are discussed, and future directions are suggested. Author

**N91-20112*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**OVERVIEW OF ROTORCRAFT AND GENERAL AVIATION PROPULSION TECHNOLOGY**
John J. Coy and Joseph D. Eisenberg *In its* Aeropropulsion 1991 Mar. 1991 14 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 21E

An overview of NASA's propulsion research that is aimed at applications for rotary winged flight and general aviation is presented. The strategic goal of this research effort is to provide innovative technologies that will strengthen the nation's competitive stance in the world market for the civil sector, and also provide superior rotorcraft for U.S. military use. The NASA Lewis tactical plan for achieving this strategic goal is the following: (1) to reduce fuel consumption of small engines by 30 percent through use of advanced cycles (including higher pressure and temperature operation) and with improved turbomachinery components technology and ceramic materials; (2) to contribute to fuel savings through weight savings and to reliability by developing advanced technology for transmissions; (3) to contribute to aircraft safety by providing advanced anti-icing and deicing technology; and (4) to achieve high-speed capability through advanced propulsion systems. Author

**N91-20113*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**TURBOMACHINERY AND COMBUSTOR TECHNOLOGY FOR SMALL ENGINES**
Lawrence J. Bober and Richard W. Niedzwiecki *In its* Aeropropulsion 1991 Mar. 1991 25 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 21E

The goal of the Small Turbine Engine Technology Program is to significantly increase thermal efficiency, reliability, and durability of future small gas turbine engines. Significant fuel savings can be achieved through component and cycle improvements as well as through the use of regeneration and uncooled ceramic materials. Recent efforts to identify new regeneration concepts have not been successful, and as a result, no active regenerator research is in progress. Development of uncooled ceramic technology is taking place at the NASA Lewis Research Center under the Department of Energy funded Advanced Turbine Technology Applications Project (ATTAP). Component research is emphasized and includes work on the compressor, combustor, and turbine. Author

**N91-20114*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**ROTARY ENGINE TECHNOLOGY**
Edward A. Willis and John J. McFadden *In its* Aeropropulsion 1991 Mar. 1991 11 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 21E

The original goal in this program was to combine some of the better features of reciprocating and gas-turbine engines; thus, obtaining a superior powerplant for light aircraft and a host of related uses. Based on a series of engine and aircraft/mission studies conducted in the early 1980's, the rotary (Wankel) engine was perceived to have many of the desired features and was judged to be capable of considerable further development. At the time, existing automotive rotary engines had demonstratably high power outputs in a compact, smooth-running, and reliable package but were less fuel efficient than comparable reciprocating engines. Accordingly, the basic thrust of the NASA Rotary Engine Technology Enablement Program was (and is) to bring the rotary's efficiency up to the level of a comparably sized diesel, without sacrificing its other desirable features. Author

**N91-20115*#** Army Aviation Systems Command, Cleveland, OH. Propulsion Directorate.
**ADVANCED ROTORCRAFT TRANSMISSION TECHNOLOGY c37**
David G. Lewicki *In* NASA, Lewis Research Center, Aeropropulsion 1991 Mar. 1991 15 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 13I

The NASA Lewis Research Center and the Propulsion Directorate of the U.S. Army Aviation Systems Command are involved in a joint research program to advance the technology of rotorcraft transmissions. The program consists of analytical and experimental efforts to achieve the overall goals of reducing transmission weight and noise, while increasing life and reliability. The work includes in-house studies and tests, university grants, industry contracts, and joint programs with other military organizations. Highlights of recent activities in the areas of transmission and related component research are presented. Three major activities are highlighted: (1) the advanced rotorcraft transmission (ART) program; (2) a comprehensive transmission noise reduction program; and (3) a transmission diagnostics research effort. Results of recent activities are presented along with future research plans. Author

**N91-20116*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**OVERVIEW OF SUBSONIC TRANSPORT PROPULSION TECHNOLOGY**
John F. Groeneweg *In its* Aeropropulsion 1991 Mar. 1991 13 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 21E

The major elements of the NASA Lewis Research Center's Subsonic Transport Propulsion Research Program are summarized. Ultra-high-bypass ratio cycles and high-efficiency cores are being investigated for propulsive and thermal efficiency improvements, respectively. Overall efficiency gains are sought subject to the constraints of noise and emissions goals. Elements of the research program including key technical issues are discussed along with the planned sequence of the activities. Author

**N91-20117*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**ULTRA-HIGH BYPASS RESEARCH**
Christopher J. Miller, James H. Dittmar, and Robert J. Jeracki *In its* Aeropropulsion 1991 Mar. 1991 14 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 21E

An overview of the ultra-high bypass research at the NASA Lewis Research Center is presented. Over the past decade, the program was focused on unducted rotors and precipitated several development efforts in industry. In this area, forward swept unducted rotors are the concluding effort. Forward sweep can reduce the tip vortex strength and has a potential for reducing the noise of counter-rotating unducted rotors. The aerodynamic performance can also be improved slightly over an aft-swept blade. The future direction of the program is toward ultra-high bypass ratio ducted machines, and short cowls as a particular item. Short cowls can have less aerodynamic drag and less weight, but many allow more noise to be radiated. In general, the aerodynamic research effort will be to provide higher efficiencies, sufficient flow conditioning, and attached flow at high angles of attack. Acoustically, the research is directed towards developing an understanding of fan acoustics in short ducts. The reduced duct length means that there might be insufficient duct length for acoustic cutoff. With less length and less cowl thickness, the space for acoustic treatment is limited, requiring integrated aeroacoustic designs. Author

**N91-20118*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**HIGH-EFFICIENCY CORE TECHNOLOGY**
Robert M. Plencner and Gerald Knip, Jr. *In its* Aeropropulsion 1991 Mar. 1991 12 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 21E

Studies were undertaken to determine the potential benefits from implementing aircraft turbine engine core technology well beyond that being developed for the next generation of long-haul subsonic transport engines (i.e., entry into service date of 1993). These core improvements, projected for year 2010 technology, include the use of very high-pressure-ratio cycles, advanced lightweight materials with minimal cooling requirements, and improved component efficiencies. The studies indicate that a large improvement is possible with engines using these advanced cores as compared to the current turbine engine designs. The results of the studies are presented, and the key challenges to achieving the predicted improvements in performance are identified. Author

**N91-20119*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**MULTIDISCIPLINARY RESEARCH OVERVIEW (IHPTET/NPSS)**
Lester D. Nichols and Susan M. Johnson *In its* Aeropropulsion 1991 Mar. 1991 20 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 21E

The Integrated High Performance Turbine Engine Technology (IHPTET) Program and the Numerical Propulsion System Simulation (NPSS) Program are two aeropropulsion multidisciplinary efforts at NASA Lewis that complement each other. The IHPTET initiative is an experimental program to advance engine development and double propulsion system capability by the turn of the century. NASA Lewis is contributing, with the Department of Defense and seven major aerospace contractors, to the development of these advanced, military, high-performance engines in the areas of compressors, combustors, turbines, nozzles, controls, mechanical systems, instrumentation, materials, structures, and computational fluid dynamics. The NPSS effort is a computational, long-range program with the goal of reducing the cost and time of development for advanced-technology propulsion systems. This goal will be achieved through a cooperative effort of NASA, industry, universities, and other government agencies to develop the necessary technologies for integrating disciplines, components, and high-performance computing into a user-friendly simulation environment. This simulation allows for comprehensive evaluation of new concepts early ing the design phase, before a commitment to hardware is made. It also allows for rapid assessment of field-related problems, particularly where operational problems are encountered during conditions that are difficult to simulate experimentally. Data generated from the IHPTET engines will be used to help validate NPSS computations. Author

**N91-20120*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**NASA'S AIRCRAFT ICING TECHNOLOGY PROGRAM** **c03**
John J. Reinmann *In its* Aeropropulsion 1991 Mar. 1991 24 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 01C

NASA's Aircraft Icing Technology Program is aimed at developing innovative technologies for safe and efficient flight into forecasted icing. The program addresses the needs of all aircraft classes and supports both commercial and military applications. The program is guided by three key objectives: (1) to numerically simulate an aircraft's response to an in-flight icing encounter; (2) to provide improved capabilities and techniques for ground and flight icing testing; and (3) offer innovative approaches to ice protection. The fundamental research focuses on topics that directly support stated industry needs, and work is performed closely with industry to assure a rapid and smooth transfer of technology. The progress toward the three stated strategic objectives is reviewed. Author

**N91-20121*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**RECENT ADVANCES IN LEWIS AEROPROPULSION FACILITIES** **c09**
Frank J. Kutina, Jr. *In its* Aeropropulsion 1991 Mar. 1991 12 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 14B

Guided by the aeropropulsion strategic plan, Lewis Research Center was systematically refurbishing and upgrading its aeropropulsion facilities through a combination of research and development and construction of facilities funding. Currently, much of the work is accomplished as a part of the NASA Aeronautical Facility Revitalization Program. The total effort is addressing issues of improved flight simulation, improved productivity, capability to support advanced aeropropulsion systems, increased computational capability, and recertification. An overview of the changes brought about by this effort is presented. Author

**N91-20122*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**IMPAC: AN INTEGRATED METHODOLOGY FOR PROPULSION AND AIRFRAME CONTROL**
Sanjay Garg, Peter J. Ouzts, Carl F. Lorenzo, and Duane L. Mattern (Sverdrup Technology, Inc., Brook Park, OH.) 1991 28 p Prepared for presentation at the American Control Conference, Boston, MA, 26-28 Jun. 1991; sponsored in part by American Automatic Control Council
(NASA-TM-103805; E-6035; NAS 1.15:103805) Avail: NTIS HC/MF A03 CSCL 21E

The National Aeronautics and Space Administration is actively involved in the development of enabling technologies that will lead towards aircraft with new/enhanced maneuver capabilities such as Short Take-Off Vertical Landing (STOVL) and high angle of attack performance. Because of the high degree of dynamic coupling between the airframe and propulsion systems of these types of aircraft, one key technology is the integration of the flight and propulsion control. The NASA Lewis Research Center approach to developing Integrated Flight Propulsion Control (IFPC) technologies is an in-house research program referred to as IMPAC (Integrated Methodology for Propulsion and Airframe Control). The goals of IMPAC are to develop a viable alternative to the existing integrated control design methodologies that will allow for improved system performance and simplicity of control law synthesis and implementation, and to demonstrate the applicability of the

methodology to a supersonic STOVL fighter aircraft. Based on some preliminary control design studies that included evaluation of the existing methodologies, the IFPC design methodology that is emerging at the Lewis Research Center consists of considering the airframe and propulsion system as one integrated system for an initial centralized controller design and then partitioning the centralized controller into separate airframe and propulsion system subcontrollers to ease implementation and to set meaningful design requirements for detailed subsystem control design and evaluation. An overview of IMPAC is provided and detailed discussion of the various important design and evaluation steps in the methodology are included. Author

**N91-20123#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**NUMERICAL ANALYSIS OF AN AXISYMMETRIC THRUST AUGMENTING EJECTOR M.S. Thesis**
Kenneth R. Gage Dec. 1990 107 p
(AD-A230555; AFIT/GAE/ENY/89D-10) Avail: NTIS HC/MF A06 CSCL 01/3

Use of an ejector is an effective way to increase the thrust produced by a jet. In this thesis project an axisymmetric ejector concept which had been previously explored by experiment was numerically modeled. An existing axisymmetric, internal flow code based on the explicit MacCormack method was modified to incorporate primary nozzle structure and flow injection within the flowfield. Results were compared qualitatively and quantitatively with experimental results to verify the validity of the model. Internal flow structure, difficult to obtain in experiment, is easily examined. This code may be used for parametric analysis of such ejector performance parameters as primary nozzle location, flow injection angle, diffuser area ratio, and inlet geometry to optimize future hardware configurations. GRA

**N91-20124#** Institut Franco-Allemand de Recherches, Saint-Louis (France).
**MEAN AND TURBULENT VELOCITY MEASUREMENTS IN A TURBOJET EXHAUST**
H. J. Schaefer and E. W. Sommer 12 Dec. 1989 22 p Presented at the International Congress on Instrumentation in Aerospace Simulation Facilities, Goettingen, Fed. Republic of Germany, 18-21 Sep. 1989 Previously announced in IAA as A90-28272
(ISL-CO-244/89; ETN-91-98986) Avail: NTIS HC/MF A03

Laser Doppler velocimeter measurements were conducted in a round high speed high temperature jet exhausting from a small scale turbojet propulsion engine. A survey of the jet flow field at Mach numbers of 46, 0.67 and 0.84 and a spectral analysis of the velocity fluctuations are presented. In good agreement with the results obtained in isothermal jets, the radial distributions of the mean and root mean square velocities can be approximated by universal profiles. The spectra of the fluctuations exhibit a pronounced narrowband peak providing evidence for the existence of coherent structures in the jet flow. ESA

**N91-20125#** Royal Aerospace Establishment, Farnborough (England). Dept. of Propulsion.
**COMBUSTOR EXIT TEMPERATURE DISTORTION EFFECTS ON HEAT TRANSFER AND AERODYNAMICS WITHIN A ROTATING TURBINE BLADE PASSAGE**
S. P. Harasgama 26 Nov. 1990 13 p
(RAE-TM-P-1195; BR115809; ETN-91-99005) Copyright Avail: NTIS HC/MF A03

A numerical simulation of temperature distortion at inlet to a rotating turbine rotor is described. A three dimensional Navier-Stokes code and the STAN5 two dimensional boundary layer code were used. The results show that the hot gas is transported to the pressure surface of the blade and that hot gas also migrates to the blade pressure side tip. At locations greater than 50 to 60 percent axial chord the hot gas enters the tip gap and emerges over the suction side. These computations are in agreement with previous experimental results. The secondary flows within the turbine rotor are enhanced by the introduction of inlet radial temperature distortion and this is in accord with previous analytical work. It is shown that the heat flux near the tip region on the pressure side of the blade can be increased by up to 76 percent due to the redistribution on the inlet temperature distortion. ESA

**N91-20126*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**PERFORMANCE OF A HIGH-WORK, LOW-ASPECT-RATIO TURBINE STATOR TESTED WITH A REALISTIC INLET RADIAL TEMPERATURE GRADIENT**
Roy G. Stabe and John R. Schwab Mar. 1991 31 p
(NASA-TM-103738; E-5975; NAS 1.15:103738) Avail: NTIS HC/MF A03 CSCL 21E

A 0.767-scale model of a turbine stator designed for the core of a high-bypass-ratio aircraft engine was tested with uniform inlet conditions and with an inlet radial temperature profile simulating engine conditions. The principal measurements were radial and circumferential surveys of stator-exit total temperature, total pressure, and flow angle. The stator-exit flow field was also computed by using a three-dimensional Navier-Stokes solver. Other than temperature, there were no apparent differences in performance due to the inlet conditions. The computed results compared quite well with the experimental results. Author

**N91-20127#** National Aerospace Lab., Tokyo (Japan).
**EXPERIMENT ON A RECTANGULAR CROSS SECTION SCRAMJET COMBUSTOR**
Tomoyuki Komuro, Kenji Kudo, Goro Masuya, Nobuo Chinzei, Atsuo Murakami, and Kouichiro Tani Jun. 1990 17 p In JAPANESE; ENGLISH summary
(NAL-TR-1068; ISSN-0389-4010) Avail: NTIS HC/MF A03

An experimental study was made on a rectangular cross section scramjet combustor in a Mach 2.5 vitiated air flow. Hydrogen fuel was injected perpendicularly from circular orifices downstream of rearward facing steps. For various fuel flow rates, air stagnation temperature and combustor length, wall static pressure, instream gas composition and Pitot pressure were measured. The higher the fuel flow rate or the lower the air stagnation temperature was, the farther upstream combustion influence extended. The distance of the upstream influence correlated well with the peak wall pressure. With a high fuel flow rate, there was no trace of each fuel jet left on local equivalence ratio contours. The mixing and combustion efficiencies showed high value, even near the fuel injector, but they did not increase significantly farther downstream. Author

# 08 AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

For related information see also *05 Aircraft Design, Testing and Performance.*

**N91-20128*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**A CONTROLS ENGINEERING APPROACH FOR ANALYZING AIRPLANE INPUT-OUTPUT CHARACTERISTICS**
P. Douglas Arbuckle Washington Apr. 1991 22 p
(NASA-TP-3072; L-16798; NAS 1.60:3072) Avail: NTIS HC/MF A03 CSCL 01C

An engineering approach for analyzing airplane control and output characteristics is presented. State-space matrix equations describing the linear perturbation dynamics are transformed from physical coordinates into scaled coordinates. The scaling is accomplished by applying various transformations to the system to employ prior engineering knowledge of the airplane physics. Two different analysis techniques are then explained. Modal analysis techniques calculate the influence of each system input on each fundamental mode of motion and the distribution of each mode among the system outputs. The optimal steady state response technique computes the blending of steady state control

inputs that optimize the steady state response of selected system outputs. Analysis of an example airplane model is presented to demonstrate the described engineering approach. Author

**N91-20129*#** Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.
**CONTROL SYSTEM FAILURE MONITORING USING GENERALIZED PARITY RELATIONS M.S. Thesis Interim Technical Report**
Christiaan Mauritz VanSchalkwyk Feb. 1991 109 p
(Grant NAG1-968)
(NASA-CR-187945; NAS 1.26:187945) Copyright Avail: NTIS HC/MF A06 CSCL 01C

Many applications require that a control system must be tolerant to the failure of its components. This is especially true for large space-based systems that must work unattended and with long periods between maintenance. Fault tolerance can be obtained by detecting the failure of the control system component, determining which component has failed, and reconfiguring the system so that the failed component is isolated from the controller. Component failure detection experiments that were conducted on an experimental space structure, the NASA Langley Mini-Mast are presented. Two methodologies for failure detection and isolation (FDI) exist that do not require the specification of failure modes and are applicable to both actuators and sensors. These methods are known as the Failure Detection Filter and the method of Generalized Parity Relations. The latter method was applied to three different sensor types on the Mini-Mast. Failures were simulated in input-output data that were recorded during operation of the Mini-Mast. Both single and double sensor parity relations were tested and the effect of several design parameters on the performance of these relations is discussed. The detection of actuator failures is also treated. It is shown that in all the cases it is possible to identify the parity relations directly from input-output data. Frequency domain analysis is used to explain the behavior of the parity relations. Author

**N91-20130*#** Washington Univ., Seattle. Dept. of Mechanical Engineering.
**MULTIRATE SAMPLED-DATA YAW-DAMPER AND MODAL SUPPRESSION SYSTEM DESIGN Final Report, 1 Sep. 1989 - 31 Dec. 1990**
Martin C. Berg and Gregory S. Mason Dec. 1990 101 p
(Grant NAG1-1055)
(NASA-CR-188017; NAS 1.26:188017) Avail: NTIS HC/MF A06 CSCL 01C

A multirate control law synthesized algorithm based on an infinite-time quadratic cost function, was developed along with a method for analyzing the robustness of multirate systems. A generalized multirate sampled-data control law structure (GMCLS) was introduced. A new infinite-time-based parameter optimization multirate sampled-data control law synthesis method and solution algorithm were developed. A singular-value-based method for determining gain and phase margins for multirate systems was also developed. The finite-time-based parameter optimization multirate sampled-data control law synthesis algorithm originally intended to be applied to the aircraft problem was instead demonstrated by application to a simpler problem involving the control of the tip position of a two-link robot arm. The GMCLS, the infinite-time-based parameter optimization multirate control law synthesis method and solution algorithm, and the singular-value based method for determining gain and phase margins were all demonstrated by application to the aircraft control problem originally proposed for this project. Author

**N91-20131#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**AUTOMATIC FLIGHT CONTROL SYSTEM DESIGN FOR AN UNMANNED RESEARCH VEHICLE USING DISCRETE QUANTITATIVE FEEDBACK THEORY M.S. Thesis**
David G. Wheaton Dec. 1990 275 p
(AD-A230364; AFIT/GE/ENG/90D-66) Avail: NTIS HC/MF A12 CSCL 01/4

This thesis presents the application of non-minimum phase (NMP) w'-plane discrete MIMO (multiple-input-multiple-output) Quantitative Feedback Theory (QFT) to the design of a three-axis rate-commanded automatic flight control system for an unmanned research vehicle (URV). The URV model used has seven inputs and three outputs derived from the small-angle perturbation equations of motion. Plant parameter uncertainty consists of six flight conditions derived from variations in the aircraft center of gravity, airspeed, and gross weight. A weighting matrix delta is used to post-multiply the plants for blending the seven effector inputs into three effective rate-command inputs and resulting in an effective plant Pe = P delta. Second order effector models and first order feedback sensor models are included in the plant. A time-scaled recursive algorithm is used to transform the continuous plant models to the w'-plane thereby avoiding the numeric problems associated with an intermediate z-plane representation. All the URV plant elements are minimum phase (MP). The transformation produces, however, a sampling NMP zero and one other NMP zero due to the three pole excess actuator/sensor model elements. These NMP elements limit the available loop bandwidth. Standard QFT design is used, with plant templates P = (P(jv)) which quantitatively express the plant uncertainty. Due to the loop bandwidth limitations, only stability bounds are derived. GRA

**N91-20132#** Sparta, Inc., Laguna Hills, CA.
**METHODOLOGY FOR DEVELOPMENT AND VERIFICATION OF FLIGHT CRITICAL SYSTEMS Final Report, Jan. - Jun. 1990**
P. DeFeo and D. Mann Oct. 1990 33 p
(Contract F33615-89-C-3608)
(AD-A229800; WRDC-TR-90-3066) Avail: NTIS HC/MF A03 CSCL 12/6

The technology needs are addressed of Vehicles Management Systems (VMS) during the critical phases of architecture definition and preliminary design. VMS are flight systems which are highly integrated for enhancing maneuvering performance, weapon delivery and fault tolerance. SPARTA has developed and demonstrated a powerful and flexible rapid prototyping environment, Transputer base Advanced Development Environment or TRADE, where VMS architectures can be rapidly emulated and evaluated. The environment includes a SUN workstation and a network of transputers. Transputers are single chip computers which provide extensive processing and communication capabilities at very low cost. The environment enables the system designer, via a graphic based User Interface (UI), to: rapidly and easily modify the VMS architecture as well as the structure of the software embedded in each VMS processor and control the entire environment. Evaluation tools which address system level issues are also included in the environment, so that the relative merits of competing architectures can be quantitatively evaluated. GRA

**N91-20133*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**A METHOD FOR PARTITIONING CENTRALIZED CONTROLLERS**
Phillip Schmidt, Sanjay Garg (Sverdrup Technology, Inc., Brook Park, OH.), and Carl F. Lorenzo Apr. 1991 9 p
(NASA-TM-4276; E-5800; NAS 1.15:4276) Avail: NTIS HC/MF A02 CSCL 01C

The notion of controller partitioning is described. Conditions are developed under which the input/output behavior of a multi-input multi-output centralized controller can be exactly matched by two separate subsystem controllers interconnected through output crossfeed. A systematic method is developed for determining a controller partitioning which best approximates the input/output behavior of the centralized controller for the general case when the exact matching conditions are not satisfied. The controller partitioning procedure is demonstrated for a centralized integrated flight/propulsion controller designed in a previous study. Author

**N91-20134#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**MULTI-INPUT MULTI-OUTPUT FLIGHT CONTROL SYSTEM DESIGN FOR THE YF-16 USING NONLINEAR QFT AND PILOT COMPENSATION M.S. Thesis**
Russell B. Miller Dec. 1990 150 p
(AD-A230465; AFIT/GE/ENG/90D-42) Avail: NTIS HC/MF A07 CSCL 01/4

Nonlinear Quantitative Feedback Theory (QFT) and pilot compensation techniques are used to design a 2x2 flight control system for the YF-16 aircraft over a large range of plant uncertainty. The design is based on numerical input-output time histories generated with a FORTRAN implemented nonlinear simulation of the YF-16. The first step of the design process is the generation of a set of equivalent linear time-invariant (LTI) plant models to represent the actual nonlinear plant. It has been proven that the solution to the equivalent plant problem is guaranteed to solve the original nonlinear problem. Standard QFT techniques are then used in the design synthesis based on the equivalent plant models. A detailed mathematical development of the method used to develop these equivalent LTI plant models is provided. After this inner loop design, pilot compensation is developed to reduce the pilot's workload. This outer loop design is also based on a set of equivalent LTI plant models. This is accomplished by modeling the pilot parameters that result in good handling qualities ratings, and developing the necessary compensation to force the desired system responses. GRA

**N91-20135#** Cranfield Inst. of Tech., Bedford (England). Coll. of Aeronautics.
**INITIAL REVIEW OF RESEARCH INTO THE APPLICATION OF MODIFIED STEPWISE REGRESSION FOR THE ESTIMATION OF AIRCRAFT STABILITY AND CONTROL PROCEDURES Quarterly Report No. 1**
M. V. Cook and H. A. Hinds Jan. 1989 33 p
(Cranfield-Aero-8903; ISBN-1-871564-05-0; ETN-91-99010)
Avail: NTIS HC/MF A03; Cranfield Inst. of Technology, Coll. of Aeronautics, Cranfield, Bedford MK43 0AL, England, HC 8 sterling pounds

Research on applying Modified Stepwise Regression (MSR) to a simple four degrees of freedom model to confirm the method for the estimation of aircraft stability and control parameters for complex models is reported. The MSR technique and an example of its application, where a data set was created using a fourth order Runge-Kutta integration computer program with a stepsize of 0.0001, are summarized. The wind tunnel, model suspension system, electronic control unit, aircraft model and data analysis of the High Incidence Research Model (HIRM) are outlined. Theoretical development objectives of MSR theory for parameter estimation, data processing algorithms and a mathematical model of the dynamic wind tunnel model aircraft are described. Equations describing longitudinal and lateral motion of an aircraft are considered. An assessment of the research stage and short term goals is given. ESA

**N91-20136#** Cranfield Inst. of Tech., Bedford (England). Coll. of Aeronautics.
**MEASUREMENT OF THE LONGITUDINAL STATIC STABILITY AND THE MOMENTS OF INERTIA OF A 1/12TH SCALE MODEL OF A B.Ae HAWK Quarterly Report No. 6**
H. A. Hinds and M. V. Cook May 1990 61 p
(Cranfield-Aero-9009; ISBN-1-871564-07-7; ETN-91-99015)
Avail: NTIS HC/MF A04; Cranfield Inst. of Technology, Coll. of Aeronautics, Cranfield, Bedford MK43 0AL, England, HC 8 sterling pounds

As part of a program to investigate the use of a Modified Stepwise Regression (MSR) procedure to estimate the stability and control parameters of a small British Aerospace Hawk aircraft model flown in a dynamic wind tunnel facility, work carried out on the Hawk model and dynamic rig facility is reported. Measurement of the model moments of inertia is described. Details of the analysis of the longitudinal stability of the model are presented. Various scaling laws are reviewed and some full scale and model Hawk parameters are given. A BASIC program to convert recorded data to the ASCII format required by the MSR program, which includes a numerical method to generate attitude angle rate data by the numerical differentiation of specified channels, is presented. The progress made with their data acquisition system is described. ESA

**N91-20137#** Cranfield Inst. of Tech., Bedford (England). Coll. of Aeronautics.
**STEADY-STATE EXPERIMENTS FOR MEASUREMENTS OF AERODYNAMIC STABILITY DERIVATIVES OF A HIGH INCIDENCE RESEARCH MODEL USING THE COLLEGE OF AERONAUTICS WHIRLING ARM**
M. J. M. Mulkens and A. O. Ormerod Aug. 1990 118 p
(Cranfield-Aero-9014; ISBN-1-871564-11-5; ETN-91-99017)
Avail: NTIS HC/MF A06; Cranfield Inst. of Technology, Coll. of Aeronautics, Cranfield, Bedford MK43 0AL, England, HC 10 sterling pounds

Work for a high incidence research project is presented. Measurements of the effects of steady pitching and yawing on HIRM (High Incidence Research Model) 1 and 2 are described. The development of the (internal) strain gauge balance and models used in these tests is described. Additional work, not reported, involved transient experiments using the whirling arm. The specially designed model and balance system were mounted on the whirling arm rig, as used for other projects. The signals coming from the balance were measured and processed, deriving the three moments, side and normal force acting on the model. Further processing by computer programs provided the aerodynamic coefficients and stability derivatives. A five hole nose probe mounted on the model was used in some tests, to give improved data on angle of attack and dynamic pressure. Geometric incidence information was obtained from a linear transducer linked to the incidence changing mechanism. ESA

**N91-20138#** Norwegian Defence Research Establishment, Kjeller.
**SPECIFICATION OF THE AUTONOMOUS MISSILE GUIDANCE PROBLEM FOR THE TA11 PROCESSOR. VOLUME 1: METHODOLOGY**
Einar Oestevold, Idar Dyrdal, Stein Grinaker, Eilert Heyerdahl, Hans C. Palm, and Geir A. Storhaug 20 Sep. 1990 24 p
(FFI-90/4005-Vol-1; ISSN-0802-2437; ETN-91-99052) Avail: NTIS HC/MF A03

The algorithm specification work carried out as a basis for the construction of the Independent European Program Group/Technical Area (TA) 11 processor is presented in nine volumes. This is a general image processor developed for the TA11 project: a cooperative research program on intelligent target tracking and acquisition techniques for guided missiles. Participating nations are the U.K. and Norway. The first part of the specification is a general structured analysis of the entire autonomous missile guidance problem where Yourdon/DeMarco formalism is used. This analysis has three parts: a data flow diagram depicting the structure of the problem; a data dictionary specifying dataflows between processes; and a processor minispec describing all basic (terminal) processes involved. The second part of the specification is aimed at deriving implementation independent numbers for the complexity of processes and for data volumes and rates. Since the TA11 processor is to be a general image processor, complexity is given by a detailed specification of a wide range of example algorithms. To derive the overall (simultaneous) complexity, operational modes identifying concurrent processes are defined. The methodology and different steps in the specification work are described and the method of using the specification is indicated. ESA

**N91-20139#** Norwegian Defence Research Establishment, Kjeller.
**SPECIFICATION OF THE AUTONOMOUS MISSILE GUIDANCE PROBLEM FOR THE TA11 PROCESSOR. VOLUME 2: GENERAL DATA FLOW DIAGRAM**
Einar Oestevold, Idar Dyrdal, Stein Grinaker, Eilert Heyerdahl, Hans

C. Palm, and Geir A. Storhaug 20 Sep. 1990 20 p (FFI-90/4005-Vol-2; ISSN-0802-2437; ETN-91-99053) Avail: NTIS HC/MF A03

The algorithm specification work carried out as a basis for the construction of the Independent European Program Group/Technical Area (TA) 11 processor is presented in nine volumes. This is a general image processor developed for the TA11 project: a cooperative research program on intelligence target tracking and acquisition techniques for guided missiles. Participating nations are the U.K. and Norway. The first part of the specification is a general structured analysis of the entire autonomous missile guidance problem where Yourdon/DeMarco formalism is used. This analysis has three parts: a data flow diagram depicting structure of the problem; a data dictionary specifying data flows between processes; and a processor minispec describing all basic (terminal) processes involved. The second part of the specification is aimed at deriving implementation independent numbers for the complexity of processes and for data volumes and rates. Since the TA11 processor is to be a general image processor, complexity is given by a detailed specification of a wide range of example algorithms. To derive the overall (simultaneous) complexity, operational modes identifying concurrent processes are defined. The general data flow diagrams are presented as a part of a general specification of the autonomous missile guidance problem. ESA

**N91-20140#** Norwegian Defence Research Establishment, Kjeller.

**SPECIFICATION OF THE AUTONOMOUS MISSILE GUIDANCE PROBLEM FOR THE TA11 PROCESSOR. VOLUME 3: DATA DICTIONARY**

Einar Oestevold, Idar Dyrdal, Stein Grinaker, Eilert Heyerdahl, Hans C. Palm, and Geir A. Storhaug 20 Sep. 1990 62 p (FFI-90/4005-Vol-3; ISSN-0802-2437; ETN-91-99054) Avail: NTIS HC/MF A04

The algorithm specification work carried out as a basis for the construction of the Independent European Program Group/Technical Area (TA) 11 processor is presented in nine volumes. This is a general image processor developed for the TA11 project: 'a cooperative research program on intelligent target tracking and acquisition techniques for guided missiles'. The first part of the specification is a general structured analysis of the entire autonomous missile guidance problem where Yourdon/DeMarco formalism is used. This analysis has three parts; a data flow diagram depicting structure of the problem; a data dictionary specifying data flows between processes; and a processor minispec describing all basic (terminal) processes involved. The second part of the specification is aimed at deriving implementation independent numbers for the complexity of processes and for data volumes and rates. Since the TA11 processor is to be a general image processor, complexity is given by a detailed specification of a wide range of example algorithms. To derive the overall (simultaneous) complexity, operational modes identifying concurrent processes are defined. The data dictionary is presented as a part of the general specification of the autonomous missile guidance problem. ESA

**N91-20141#** Norwegian Defence Research Establishment, Kjeller.

**SPECIFICATION OF THE AUTONOMOUS MISSILE GUIDANCE PROBLEM FOR THE TA11 PROCESSOR. VOLUME 5: SPECIFICATION MODE 15, A + T + B + H**

Einar Oestevold, Idar Dyrdal, Stein Grinaker, Eilert Heyerdahl, Hans C. Palm, and Geir A. Storhaug 20 Sep. 1990 168 p (FFI-90/4005-Vol-5; ISSN-0802-2437; ETN-91-99056) Avail: NTIS HC/MF A08

The algorithm specification work carried out as a basis for the construction of the Independent European Program Group/Technical Area (TA) 11 processor is presented in nine volumes. This is a general image processor developed for the TA11 project: a cooperative research program on intelligent target tracking and acquisition techniques for guided missiles. Participating nations are the U.K. and Norway. The first part of the specification is a general structured analysis of the entire autonomous missile guidance problem where Yourdon/DeMarco formalism is used. This analysis has three parts: a data flow diagram depicting the structure of the problem; a data dictionary specifying data flows between processes; and a processor minispec describing all basic (terminal) processes involved. The second part of the specification is aimed at deriving implementation independent numbers for the complexity of processes and for data volumes and rates. Since the TA11 processor is to be a general image processor, complexity is given by a detailed specification of a wide range of example algorithms. To derive the overall (simultaneous) complexity, operational modes identifying concurrent processes are defined. Quantitative specifications relating to the acquisition, tracking, background analysis, and aim point analysis are presented. ESA

**N91-20142#** Norwegian Defence Research Establishment, Kjeller.

**SPECIFICATION OF THE AUTONOMOUS MISSILE GUIDANCE PROBLEM FOR THE TA11 PROCESSOR. VOLUME 9: SPECIFICATION OF SUB-PROCESSES**

Einar Oestevold, Idar Dyrdal, Stein Grinaker, Eilert Heyerdahl, Hans C. Palm, and Geir A. Storhaug 20 Sep. 1990 101 p (FFI-90/4005-Vol-9; ISSN-0802-2437; ETN-91-99060) Avail: NTIS HC/MF A06

The algorithm specification work carried out as a basis for the construction of the Independent European Program Group/Technical Area (TA) 11 processor is presented in nine volumes. This is a general image processor developed for the TA11 project: a cooperative research program on intelligent target tracking and acquisition techniques for guided missiles. Participating nations are the U.K. and Norway. The first part of the specification is a general structured analysis of the entire autonomous missile guidance problem where Yourdon/DeMarco formalism is used. This analysis has three parts: a data flow diagram depicting the structure of the problem; a data dictionary specifying data flows between processes; and a processor minispec describing all basic (terminal) processes involved. The second part of the specification is aimed at deriving implementation independent numbers for the complexity of processes and for data volumes and rates. Since the TA11 processor is to be a general image processor, complexity is given by a detailed specification of a wide range of example algorithms. To derive the overall (simultaneous) complexity, operational modes identifying concurrent processes are defined. Detailed specifications of the basic processes (subprocesses) are presented for the mode related specifications. Subprocesses are acquisition, tracking, background analysis, aim point analysis, and navigation. ESA

# 09 RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.

For related information see also *14 Ground Support Systems and Facilities (Space).*

**N91-20143*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**CRYOGENIC WIND TUNNELS: A COMPREHENSIVE, ANNOTATED BIBLIOGRAPHY**

Marie H. Tuttle, Robert A. Kilgore, and Deborah L. Moore (Vigyan Research Associates, Inc., Hampton, VA.) Washington Apr. 1991 136 p Supersedes NASA-TM-80168, NASA-TM-84474, NASA-TM-86346, and NASA-TM-4013 (NASA-TM-4273; L-16919; NASA-TM-80168; NASA-TM-84474; NASA-TM-86346; NASA-TM-4013; NAS 1.15:4273) Avail: NTIS HC/MF A07 CSCL 14B

The bibliography on cryogenic wind tunnels is presented. The intent is to list publications that would be useful to persons interested in building or using a cryogenic wind tunnel. Author

**N91-20144#** National Aerospace Lab., Tokyo (Japan).
**INVESTIGATION OF ATP BLADES, PART 1**
M. Sato, H. Kanda, N. Sudani, Y. Oguni, S. Baba, H. Miwa, I. Kawamoto, H. Shoji, K. Otake, and Y. Ichikawa et al Nov. 1989 51 p In JAPANESE; ENGLISH summary
(DE91-750103; NAL-TM-615) Avail: NTIS HC/MF A04

This is a description of 2-D transonic wind tunnel used for the present test and devices for measuring stresses exerted on the test airfoils of NACA16-202 type and NACA16-204 type, in addition to a method for processing data obtained by wind tunnel test. The test airfoil of NACA16-202 type is put to vibration test. Vibration modes obtained by this test are compared with those calculated by use of a certain Finite Element Method Model. A preliminary test is made to examine stresses exerted on the airfoils under various aerodynamic conditions. The wind tunnel test is applied to the airfoils, holding Reynolds number at 8 x 10(exp 4), and varying Mach number and angles of attack from 0.6 to 1.0 and from -10 to 16 degs, respectively. Aerodynamic characteristics of the above airfoils, which are obtained by the test, are given in detail as a series of diagrams presenting each of the relations between the following pairs of quantities; C (sub l) and alpha c, C (sub d) and C (sub l), C (sub m) and C (sub l), C (sub l)/C (sub d) and C (sub l), C (sub l) and M with constant alpha, C (sub d) and M with constant C (sub l), C (sub d) and M with constant alpha, C (sub m) and M with constant C (sub l), and C (sub m) and M with constant alpha. Here C (sub l), C (sub m), C (sub d), M, alpha and alpha c denote lift coefficient, pitching moment, drag coefficient, Mach number, angle of attack and corrected angle of attack, respectively. DOE

**N91-20145#** California Univ., Berkeley.
**DESIGN OF A STAGNATION HEATER FOR THE RAREFIED GAS WING TUNNEL M.S. Thesis**
Robert G. Booker Dec. 1990 119 p
(AD-A230689) Avail: NTIS HC/MF A06 CSCL 14/2

This report covers the fluid mechanic, heat transfer, and structural design of a stagnation heater for the Berkeley rarefied gas wind tunnel. The heater is to provide a low mass flow rate of gas for electron beam or laser diagnostic applications and is compatible with oxidizing gases at mass flow rates of 0.1 to 0.3 g/s, with an output temperature of up to 2000 K. The heater consists of an inner zirconia tube for the source gas to pass through, which is surrounded by a pressure vessel. The source gas and the pressure vessel are designed to be at up to 2000 psi (136 atm). The heater will operate at pressure ratios of up to one million, producing gas flows of at least Mach ten. Fluid mechanic analysis shows that the source gas is in laminar flow through the heater, and has a transit time of 2 to 3 seconds. An extensive parametric study is presented of heater outlet diameter versus source gas type, temperature, pressure, and mass flow rate. The heat transfer analysis assumes uniform axial temperature in the core of the heater (i.e., a constant temperature boundary condition), then finds 1-D radial heat transfer by accounting for simultaneous radiation and conduction. Heat losses at the ends are estimated iteratively by sequential 1-D conduction (through the end of the heater) and radiation (to the wind tunnel). The structural design of the heater focuses on how the pressure vessel is sealed, including determining the size and number of bolts to keep the vessel safely intact. GRA

**N91-20146*#** Institute for Computer Applications in Science and Engineering, Hampton, VA.
**MACH 4 AND MACH 8 AXISYMMETRIC NOZZLES FOR A SHOCK TUNNEL Final Report**
P. A. Jacobs and R. J. Stalker (Queensland Univ., Saint Lucia, Australia ) Feb. 1991 27 p Submitted for publication
(NASA-CR-187533; ICASE-91-24; NAS 1.26:187533) Avail: NTIS HC/MF A03 CSCL 14B

The performance of two axisymmetric nozzles which were designed to produce uniform, parallel flow with nominal Mach numbers of 4 and 8 is examined. A free-piston-driven shock tube was used to supply the nozzle with high-temperature, high-pressure test gas. The inviscid design procedure treated the nozzle expansion in two stages. Close to the nozzle throat, the nozzle wall was specified as conical and the gas flow was treated as a quasi-one-dimensional chemically-reacting flow. At the end of the conical expansion, the gas was assumed to be calorically perfect, and a contoured wall was designed (using method of characteristics) to convert the source flow into a uniform and parallel flow at the end of the nozzle. Performance was assessed by measuring Pitot pressures across the exit plane of the nozzles and, over the range of operating conditions examined, the nozzles produced satisfactory test flows. However, there were flow disturbances in the Mach 8 nozzle flow that persisted for significant times after flow initiation. Author

**N91-20099*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**INSTRUMENTATION AND CONTROLS OVERVIEW**
Norman C. Wenger *In its* Aeropropulsion 1991 Mar. 1991 8 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 14B

**N91-20121*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**RECENT ADVANCES IN LEWIS AEROPROPULSION FACILITIES**
Frank J. Kutina, Jr. *In its* Aeropropulsion 1991 Mar. 1991 12 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 14B

# 12 ASTRONAUTICS (GENERAL)

For extraterrestrial exploration see *91 Lunar and Planetary Exploration.*

**N91-20147*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**MANUAL CONTROL ASPECTS OF ORBITAL FLIGHT Abstracts Only**
Adam R. Brody, ed. (Sterling Software, Palo Alto, CA.) and Stephen R. Ellis, ed. Dec. 1990 14 p Workshop held at Moffett Field, CA, 22 Feb. 1990
(NASA-CP-10056; A-90286; NAS 1.55:10056) Avail: NTIS HC/MF A03 CSCL 22A

A brief description of several laboratories' current research in the general area of manual control of orbital flight is presented. With an operational-space-station era (and its increased traffic levels) approaching, now is an opportune time to investigate issues such as docking and rendezvous profiles and course-planning aids. The tremendous increase in the capabilities of computers and computer graphics has made extensive study possible and economical. It is time to study these areas, from a human factors and manual control perspective in order to preclude the occurrence of problems analogous to those that occurred in the airline and other related industries. For individual titles, see N91-20148 through N91-20153.

**N91-20148*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**MANUAL CONTROL ASPECTS OF ORBITAL FLIGHT Abstract Only** **c18**
Adam R. Brody (Sterling Software, Palo Alto, CA.) *In its* Manual Control Aspects of Orbital Flight Dec. 1990 p 2 (For primary document see N91-20147 12-12)
Avail: NTIS HC/MF A03 CSCL 22B

Studies of spacecraft rendezvous and docking operations began in the Gemini program in preparation for the two dockings required to send a crew to the moon and return them safely to Earth. However, the goal of getting to the moon before the end of the decade was of greater concern than mission optimization so little or no time or money was expended in researching human factors implications of operational aspects such as braking gates or control modes. Also, with sixteen operational dockings over a six year period (12 Apollo, 3 Skylab, and 1 ASTP) in the United

States space program, economies of scale were not yet available to justify extensive research into decreasing the time or fuel necessary for a successful docking. With an operational space station era approaching in which orbital maneuvering vehicle (OMV), orbital transfer vehicle (OTV), shuttle orbiter, and other traffic will play a major role, a concerted research effort now could help avoid many potential problems later in addition to increasing safety, fuel economy, and productivity. A knowledge of manual control capabilities associated with piloted spaceflight could help save a life if the operational flight envelope can be safely enlarged to include faster dockings that currently envisioned. For example, current and future research is designed to acquire the appropriate information. Author

**N91-20149*#** Rockwell International Corp., Houston, TX. Space Operations.

**ORBITAL MANEUVERING VEHICLE REMOTE PILOTING OPERATIONS Abstract Only** **c18**

Michael L. Veres *In* NASA, Ames Research Center, Manual Control Aspects of Orbital Flight Dec. 1990 p 3 (For primary document see N91-20147 12-12)

Avail: NTIS HC/MF A03 CSCL 22B

The remote piloting of spacecraft is discussed using the orbital maneuvering vehicle (OMV) as a case in point. Some challenges to remotely piloted operations are listed. Approaches to solving operation problems are discussed for the two major participants in the loop tasks involved. These tasks are the remotely piloted docking task, and the task of ensuring that the rendezvous is successfully completed. Resulting changes to the OMV system are outlined. The outcome of these changes and the approaches taken in the OMV program are presented. Comparisons are drawn between philosophies and techniques used for Space Transportation System rendezvous and proximity operations, and those currently envisioned for OMV. Finally, a few of the lessons learned are summarized. Author

**N91-20150*#** Martin Marietta Corp., Denver, CO. Astronautics Group.

**RESULTS FROM TELEOPERATED FREE-FLYING SPACECRAFT SIMULATIONS IN THE MARTIN MARIETTA SPACE OPERATIONS SIMULATOR LAB Abstract Only** **c18**

Craig S. Hartley *In* NASA, Ames Research Center, Manual Control Aspects of Orbital Flight Dec. 1990 p 4 (For primary document see N91-20147 12-12)

Avail: NTIS HC/MF A03 CSCL 22B

To augment the capabilities of the Space Transportation System, NASA has funded studies and developed programs aimed at developing reusable, remotely piloted spacecraft and satellite servicing systems capable of delivering, retrieving, and servicing payloads at altitudes and inclinations beyond the reach of the present Shuttle Orbiters. Since the mid 1970's, researchers at the Martin Marietta Astronautics Group Space Operations Simulation (SOS) Laboratory have been engaged in investigations of remotely piloted and supervised autonomous spacecraft operations. These investigations were based on high fidelity, real-time simulations and have covered a wide range of human factors issues related to controllability. Among these are: (1) mission conditions, including thruster plume impingements and signal time delays; (2) vehicle performance variables, including control authority, control harmony, minimum impulse, and cross coupling of accelerations; (3) maneuvering task requirements such as target distance and dynamics; (4) control parameters including various control modes and rate/displacement deadbands; and (5) display parameters involving camera placement and function, visual aids, and presentation of operational feedback from the spacecraft. This presentation includes a brief description of the capabilities of the SOS Lab to simulate real-time free-flyer operations using live video, advanced technology ground and on-orbit workstations, and sophisticated computer models of on-orbit spacecraft behavior. Sample results from human factors studies in the five categories cited above are provided. Author

**N91-20151*#** McDonnell-Douglas Space Systems Co., Huntington Beach, CA.

**A MANNED MANEUVERING UNIT PROXIMITY OPERATIONS PLANNING AND FLIGHT GUIDANCE DISPLAY AND CONTROL SYSTEM Abstract Only** **c18**

Gary R. Gershzohn, Robert J. Sirko, K. Zimmerman, and A. D. Jones *In* NASA, Ames Research Center, Manual Control Aspects of Orbital Flight Dec. 1990 p 5 (For primary document see N91-20147 12-12)

Avail: NTIS HC/MF A03 CSCL 22B

This task concerns the design, development, testing, and evaluation of a new proximity operations planning and flight guidance display and control system for manned space operations. A forecast, derivative manned maneuvering unit (MMU) was identified as a candidate for the application of a color, highway-in-the-sky display format for the presentation of flight guidance information. A silicon graphics 4D/20-based simulation is being developed to design and test display formats and operations concepts. The simulation includes the following: (1) real-time color graphics generation to provide realistic, dynamic flight guidance displays and control characteristics; (2) real-time graphics generation of spacecraft trajectories; (3) MMU flight dynamics and control characteristics; (4) control algorithms for rotational and translational hand controllers; (5) orbital mechanics effects for rendezvous and chase spacecraft; (6) inclusion of appropriate navigation aids; and (7) measurement of subject performance. The flight planning system under development provides for: (1) selection of appropriate operational modes, including minimum cost, optimum cost, minimum time, and specified ETA; (2) automatic calculation of rendezvous trajectories, en route times, and fuel requirements; (3) and provisions for manual override. Man/machine function allocations in planning and en route flight segments are being evaluated. Planning and en route data are presented on one screen composed of two windows: (1) a map display presenting a view perpendicular to the orbital plane, depicting flight planning trajectory and time data attitude display presenting attitude and course data for use en route; and (2) an attitude display presenting local vertical-local horizontal attitude data superimposed on a highway-in-the-sky or flight channel representation of the flight planned course. Both display formats are presented while the MMU is en route. In addition to these displays, several original display elements are being developed, including a 3DOF flight detector for attitude commanding, a different flight detector for translation commands, and a pictorial representation of velocity deviations. Author

**N91-20152*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**INTERACTIVE ORBITAL PROXIMITY OPERATIONS PLANNING SYSTEM Abstract Only**

Arthur J. Grunwald (Technion - Israel Inst. of Tech., Haifa.) and Stephen R. Ellis *In its* Manual Control Aspects of Orbital Flight Dec. 1990 p 6 Previously announced as N90-22953 (For primary document see N91-20147 12-12)

Avail: NTIS HC/MF A03 CSCL 22A

An interactive graphical planning system for on-site planning of proximity operations in the congested multispacecraft environment about the space station is presented. The system shows the astronaut a bird's eye perspective of the space station, the orbital plane, and the co-orbiting spacecraft. The system operates in two operational modes: (1) a viewpoint mode, in which the astronaut is able to move the viewpoint around in the orbital plane to range in on areas of interest; and (2) a trajectory design mode, in which the trajectory is planned. Trajectory design involves the composition of a set of waypoints which result in a fuel-optimal trajectory which satisfies all operational constraints, such as departure and arrival constraints, plume impingement constraints, and structural constraints. The main purpose of the system is to present the trajectory and the constraints in an easily interpretable graphical format. Through a graphical interactive process, the trajectory waypoints are edited until all operational constraints are satisfied. A series of experiments was conducted to evaluate the system. Eight airline pilots with no prior background in orbital

mechanics participated in the experiments. Subject training included a stand-alone training session of about 6 hours duration, in which the subjects became familiar with orbital mechanics concepts and performed a series of exercises to familiarize themselves with the control and display features of the system. They then carried out a series of production runs in which 90 different trajectory design situations were randomly addressed. The purpose of these experiments was to investigate how the planning time, planning efforts, and fuel expenditures were affected by the planning difficulty. Some results of these experiments are presented.
Author

**N91-20153*#** California Univ., Berkeley.
**SIMULATED ANNEALING IN ORBITAL FLIGHT PLANNING Abstract Only**
Jeffrey Soller *In* NASA, Ames Research Center, Manual Control Aspects of Orbital Flight Dec. 1990 p 7 (For primary document see N91-20147 12-12)
Avail: NTIS HC/MF A03 CSCL 22A

Simulated annealing is used to solve a minimum fuel trajectory problem in the space station environment. The environment is unique because the space station will define the first true multivehicle environment in space. The optimization yields surfaces which are potentially complex, with multiple local minima. Because of the likelihood of these local minima, descent techniques are unable to offer robust solutions. Other deterministic optimization techniques were explored without success. The simulated annealing optimization is capable of identifying a minimum-fuel, two-burn trajectory subject to four constraints. Furthermore, the computational efforts involved in the optimization are such that missions could be planned on board the space station. Potential applications could include the on-site planning of rendezvous with a target craft of the emergency rescue of an astronaut. Future research will include multiwaypoint maneuvers, using a knowledge base to guide the optimization.
Author

**N91-20154#** Joint Publications Research Service, Arlington, VA.
**JPRS REPORT: SCIENCE AND TECHNOLOGY. USSR: SPACE**
26 Nov. 1990 111 p Transl. into ENGLISH from various Russian articles
(JPRS-USP-90-005) Avail: NTIS HC/MF A06

Various articles from various Soviet publications are presented. The topics of study are as follows: Manned Mission Highlights; Space Sciences; Interplanetary Sciences; Life Sciences; Space Engineering; Space Applications; and Space Policy and Administration. For individual titles, see N91-20155 through N91-20170.

**N91-20155#** Joint Publications Research Service, Arlington, VA.
**DEVELOPMENT, FUNCTIONS OF KVANT-2 SUPPLEMENTARY EQUIPMENT MODULE c18**
M. M. Lemelev *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 8-16 Transl. into ENGLISH from Zemlya i Vselennaya (Moscow, USSR), no. 3, May - Jun. 1990 p 3-11 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

In accordance with the outer space research program, a Proton launch vehicle placed the specialized Kvant-2 supplementary equipment module into near Earth orbit on 26 Nov. 1989. The module docked with the Mir manned complex on 6 Dec. 1989. Diagrams and specifications are given of the Kvant-2 module.
Author

**N91-20156#** Joint Publications Research Service, Arlington, VA.
**SURVEY OF USSR, WORLD SPACE PROGRAMS**
Mikhail Tarasenko *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 17-19 Transl. into ENGLISH from Poisk (Moscow, USSR), no. 14, 7-13 Apr. 1990 p 4-5 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

The Soviet concept of common sense in space research is presented. A survey is presented of the world space programs. Number of vehicles launched, along with the national space budgets was surveyed.
Author

**N91-20157#** Joint Publications Research Service, Arlington, VA.
**GLOBAL CIRCULATION OF VENUSIAN ATMOSPHERE Abstract Only c91**
M. N. Izakov *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 33 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 28, no. 3, May - Jun. 1990 p 451-458 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

In the Venusian lower and middle latitudes, a considerable part of the atmospheric rotation outpaces planetary rotation (superrotation). This superrotation develops and is maintained as a result of negative viscosity, the transfer of energy from smaller to larger vortices, eventually leading to zonal flow. This phenomenon develops in a large scale 2-D turbulent flow generated when there is loss of stability of a Hadley cell forming at altitudes 55 to 65 km, where the absorption of solar radiation is maximal. At the same time, vorticity and temperature inhomogeneities are transferred from larger to smaller vortices, ensuring the appearance of small meridional temperature gradients. The lower lying layers are untwisted as a result of the turbulent viscosity generated by 3-D turbulence. The predominantly stable stratification is a result of stronger heating of the upper layers of the atmosphere by solar radiation. It is noted that several other explanations of superrotation have been recently published.
Author

**N91-20158#** Joint Publications Research Service, Arlington, VA.
**PRELIMINARY ANALYSIS OF VENUSIAN TECTONICS AND EVOLUTION Abstract Only c91**
A. M. Nikishin *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 33 Transl. into ENGLISH from Geotektonika (Moscow, USSR), no. 3, May - Jun. 1990 p 16-27 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

Five stages in the evolution of Venus are discussed: accretion, segregation of early crust from magma ocean; volcanic reworking of early crust, development of tectonics of soft plastic plates with formation of tesserae in compression zones and plains in dilatation zones; formation of weakened planetary zones of dilatation saturated by mantel hot-spot structures against a backdrop of dispersed mantel hot-spot tectonics and plateau volcanism. The following subjects are discussed: types of structures and structural regions of Venus; tectonic structure of Venus and its interpretation; thickness and composition of Venusian crust; model of geological evolution of Venus; asymmetry of tectonic structure of Venus; and reasons for the great differences in the tectonics of the Earth and Venus. The tectonics of Venus differ from those of the Earth because Venus was always impoverished in terms of water, a highly important agent of magmatism and the main fluid involved in the fusion fo sialic rocks. Venusian volcanism therefore was less intense and a sialic crust is largely absent. The greenhouse effect on Venus causes increased plasticity of its lithosphere.
Author

**N91-20159#** Joint Publications Research Service, Arlington, VA.
**HOMOGENEOUS DISTRIBUTION OF VOLCANIC FLOWS IN THE NORTHERN HEMISPHERE OF VENUS Abstract Only c91**
G. A. Leykin, V. K. Vorozdin, and Ye. V. Zabaluyeva *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 33 Transl. into ENGLISH from Astronomicheskiy Vestnik (Moscow, USSR), v. 24, no. 3, Jul. - Sep. 1990 p 195-202 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

The radar of Venera 15 and 16 detected a large number of small circular or irregular formations which appeared to be flowlike and of volcanic origin. The question is examined of whether the distribution of these features is random (homogeneous) or exhibits some distribution trend. The map of Venus displaying these features was divided into trapezoids 30 degs of longitude and 10 degs of

latitude in size. Two methods were used to determine the distribution features, with subsequent statistical analysis of the numerical data. The first method compared the total area of the features to the area of the trapezoid; the second determined the number of features per trapezoid. Both methods yielded identical results, and the second was easier to implement. It was found that the distribution of volcanic flows was not random in the examined region of Venus. This inhomogeneity may be due to clustering. It is possible that the volcanic flows are concentrated in the northern latitudes at 210 to 300 degs of longitude. However, this material is insufficient to confidently determine the distribution of these features with morphological and geological features.

Author

**N91-20160#** Joint Publications Research Service, Arlington, VA.
**SULFURIC ACID IN VENUSIAN ATMOSPHERE DETERMINED FROM RADIO OPACITY DATA Abstract Only** **c91**
S. S. Matyugov, O. I. Yakovlev, and V. N. Gubenko *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 35 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 28, no. 2, Mar. - Apr. 1990 p 277-281 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

A study was made of the attenuation of centimeter radio waves in the polar and near polar atmosphere of the near-polar atmosphere of the Venusian Northern Hemisphere from altitudes of 47 to 80 km. The distribution of absorbent in the planetary middle atmosphere was also sought. The research was based on the results of measurements of the amplitude of centimeter and decimeter radio waves emitted by the Venera 15 and 16 vehicles during radio opacity studies of five regions of the planetary atmosphere between latitudes of 71 and 85.5 degs at solar zenith angles of between 95.4 and 109 degs (nighttime atmosphere). The average radius of Venus was taken as a = 6.051 km. At an altitude of 61 km, the integral absorption was -2.4 dB; at 55 dm, -0.6; and at 47 km, -5.8 dB. Data were obtained on the absorption of radio waves at both lambda = 5 cm and lambda = 13 cm for altitudes attributable to sulfuric acid vapor. The distribution of H2SO4 vapor at altitudes 39 to 53 km was determined. At 39 to 44 km altitude, the content of H2SO4 vapor is slightly dependent on altitude and is = to 37 + or - 7 ppm. With an increase in altitude above the Venusian surface from 45 to 53 km, it is 20 + or - 5 ppm.

Author

**N91-20161#** Joint Publications Research Service, Arlington, VA.
**DEVELOPMENT OF MODEL OF FORMATION OF VENUSIAN NIGHTTIME IONOSPHERE FOR PERIOD OF LOW SOLAR ACTIVITY Abstract Only** **c91**
L. N. Samoznayev *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 35 Transl. into ENGLISH from Kosmicheskiye Issledovaniya, (Moscow, USSR), v. 28, no. 2, Mar. - Apr. 1990 p 282-292 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

A 2-D model of the formation of the nighttime ionosphere of Venus for a period of low solar activity which takes into account the influence of two probable sources of its formation (ionization by epithermal electrons and horizontal transport of ion from the daytime side) is tested on the basis of radio occultation data from the Venera 9, 10, 15, 16 spacecraft. Comparison of experimental and computed data supports the validity of the first of these sources; the second, together with photoionization, makes a contribution only in the region adjacent to the planetary terminator and causes a regular decrease in electron concentration at the maximum of the main layer of the ionosphere with an increase in solar zenith angle in the range of 90 to 110 degs. Although the cited data indicate a predominant influence of epithermal electrons during formation of the nighttime ionosphere, this mechanism does not explain the existence of a lower ionization maximum in the nighttime ionosphere. Since the frequency of appearance of this maximum is different in different years, it is postulated that it is formed under the influence of an unknown source whose intensity varies with the solar activity phase.

Author

**N91-20162#** Joint Publications Research Service, Arlington, VA.
**ELECTRIC FIELDS, DYNAMICS OF SO2 CONCENTRATION, POSSIBLE VULCANISM ON VENUS Abstract Only** **c91**
L. V. Ksanfomaliti *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 35-36 Transl. into ENGLISH from Astronomicheskiy Vestnik (Moscow, USSR), v. 24, no. 1, Jan. - Mar. 1990 p 59-71 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

This is an overview of the continuing debate regarding electromagnetic pulses detected by Pioneer Venus and Venera 11 to 14. The Venera pulses were presumed to be similar to terrestrial lightning. Pioneer Venus, on the night side of the planet, detected no light flashes. Vertical profiles revealed the source of the pulses to be well below the cloud layer. Furthermore, both the Venera craft and the Pioneer Venus probes encountered dense plasma at about 12 km, yet the probes were thousands of km apart, indicating a global, electrically active zone. It was presumed that the source of the discharges is volcanic activity. A description is offered of the OEFD experiment, which detected the pulses on the Pioneer Venus, and the nature of whistlers and their propagation is explained. Its findings are interpreted to support the existence of volcanic activity. The arguments for and against vulcanism on Venus are weighted, including changes in the SO2 content of the atmosphere, which the author believes is connected with volcanic eruption. Arguments are presented in favor of tectonic activity on Venus, e.g., the need to release heat from the decay of uranium, thorium, and potassium within the planet.

Author

**N91-20163#** Joint Publications Research Service, Arlington, VA.
**THE GRAVITATIONAL FIELD ON THE PHYSICAL SURFACE OF VENUS Abstract Only** **c91**
T. G. Maksimova and N. A. Chuykova *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 36 Transl. into ENGLISH from Kinematika i Fizika Nebesnykh Tel (Kiev, USSR), v. 6, no. 1, Jan. - Feb. 1990 p 19-27 Original language document was announced in IAA as A90-26385 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

In order to determine the distribution of gravitational potential and deflections of the vertical on a planet, one must choose a reference surface and a model of the potential of the planet, including external forces. The potentials of five forces are considered: gravitational potential of the planet itself; gravitational potential of the atmosphere; centrifugal potential of axial rotation; centrifugal-rotational potential of orbital revolution; and tidal potential from the Sun. It is shown that the latter three can be ignored in the calculation of the normal field. A dense atmosphere can have a significant effect on normal gravity gradients, and this is considered in the calculations. A potential model based on Pioneer Venus Doppler measurements is used to calculate gravitational anomalies.

Author

**N91-20164#** Joint Publications Research Service, Arlington, VA.
**SATELLITE GEODESY AND EARTHQUAKE PREDICTION** **c43**
M. T. Prilepin *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 47-51 Transl. into ENGLISH from Zemlya i Vselennaya (Moscow, USSR), no. 3, May - Jun. 1990 p 13-19 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

Motions and deformations of the earth's crust that may provide warning of impending seismic events have been studied for years in geodynamic test areas by geodesists of a number of countries. However, the methods of ground based geodesy are often extremely limited, and they do not yield enough observational material for earthquake prediction. Scientists are now laying high hopes on satellite geodesy. Satellite measurements make it possible to obtain information on deformation of the earth's crust over enormous territories within relatively short periods of time, with much greater accuracy than is achieved with gound based methods. The role of geodesy in the forecasting of earthquakes is examined.

Author

**N91-20165#** Joint Publications Research Service, Arlington, VA.
**CONVERSION OF THE TECHNOLOGY FOR THE PRODUCTION OF THE ENERGIYA-BURAN SYSTEM IN THE NATIONAL ECONOMY Abstract Only** **c85**
V. I. Grigoryev *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 53 Transl. into ENGLISH from Vestnik Mashinostroyeniya (Moscow, USSR), no. 5, May 1990 p 47-49 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

Two major themes are examined. First, the new procedural and organizational approaches to the development of complex systems and the new level achieved in technology, both of which facilitate breakthroughs in scientific and technical progress. Secondly, results in the conversion of aerospace technology to serve the needs of the national economy. In terms of the second theme, the gains to be expected in all sectors of the economy, from food industry to medicine, as a result of the conversion of the technologies and skills used in the development of the Energiya Buran space system. A long list of spinoffs are noted, including large scale precision investment casting, thin wall casting of aluminum alloys, titanium casting without the alpha layer, and production of mold cores without the toxic resin binders. Author

**N91-20166#** Joint Publications Research Service, Arlington, VA.
**ISSUES IN SPACE POLICY, BUDGETING** **c81**
Vsevolod Sergeyevich Avduyevskiy and Leonid Vasilyevich Leskov *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 54-72 Transl. into ENGLISH from Novoye v Zhizni, Nauke, Tekhnike: Seriya Kosmonavtika, Astronomiya (Moscow, USSR), no. 4, Apr. 1990 p 3-49 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

The book discusses the prospects for the development of the Soviet space program and analyzes the possible ways and means for increasing its return to the national economy. Author

**N91-20167#** Joint Publications Research Service, Arlington, VA.
**SPACE PROGRAMS IN PROGRAM 2005 ADVOCATED** **c85**
I. Yudin *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 78-81 Transl. into ENGLISH from Pod Znamenem Leninizma (Kiev, USSR), no. 5, Mar. 1990 p 77-81 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

The Soviet space program is analyzed in terms of the national economy and what it means for a civilized state. A program was published which outlined the development of space equipment to be used for science and national economy aims between now and the year 2005. It calls for step-by-step development of vehicles to be used for various purposes, a gradual decrease in and elimination of the lag in the technical level of domestic space equipment behind the best foreign counterparts, fuller satisfaction of the needs of science and the national economy, and the start up of preliminary work for future realization of large scale space projects, as well as the expansion of international cooperation and the commercial use of space equipment. E.R.

**N91-20168#** Joint Publications Research Service, Arlington, VA.
**SEMENOV DISCUSSES BENEFITS FROM MIR PROGRAM, SHUTTLE VERSUS ELVS, CONVERSION** **c85**
N. Mikhaylov and G. Nikolayenko *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 82-85 Transl. into ENGLISH from Pravda Ukrainy (Kiev, USSR), 12 Apr. 1990 p 4 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

An interview is presented with Semenov who attempts to justify the spending of vast sums of money of various Soviet space programs. He speaks of the gains to the national economy from the conversion of space commercialization to various sectors. E.R.

**N91-20169#** Joint Publications Research Service, Arlington, VA.
**CONTINUED DEVELOPMENT URGED FOR NUCLEAR POWER SOURCES FOR SPACECRAFT** **c73**
German Lomanov *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 94-97 Transl. into ENGLISH from Pravitelstvennyy Vestnik (Moscow, USSR), no. 26, Jun. 1990 p 6-7 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

The author is pressing his argument for the continued development of nuclear power sources for spacecraft. He states that accidents involving both Soviet and American spacecraft have occurred in space. The upshot is that he believes that regardless of the hazards attendant with the use of nuclear power, it should still be developed at least for spacecraft power supplies. Author

**N91-20170#** Joint Publications Research Service, Arlington, VA.
**US RELUCTANCE ON SPACE COOPERATION CRITICIZED Abstract Only** **c84**
A. Yakimenko *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 101 Transl. into ENGLISH from Krasnaya Zvezda (Moscow, USSR), 2 Nov. 1990 p 3 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

NASA Director R. Truly was in Moscow recently at the invitation of the USSR Ministry of General Machine Building and the Intercosmos Council of the USSR Academy of Sciences. Even before the meeting began it was possible to assume that the leaders of the space departments of the world's two greatest countries had something to say and show to each other and something on which to reach agreement in the sphere of concrete mutually advantageous businesslike cooperation. However, in the process of the meetings it was only the possible areas of cooperation that were discussed, and the meeting resulted in a protocol of intentions. Meanwhile, both U.S. and Soviet firms and scientific organizations are very interested in the mutual utilization of the achievements of space technology and in the further development of contacts in this promising sphere. Author

**N91-20171#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**APPLICATION OF INFLUENCE DIAGRAMS IN IDENTIFYING SOVIET SATELLITE MISSIONS M.S. Thesis**
Cary C. Chun Dec. 1990 127 p
(AD-A230752; AFIT/GSO/ENS/90D-7) Avail: NTIS HC/MF A07 CSCL 15/3

The feasibility is studied of applying influence diagrams to capture expert knowledge and incorporate decision theory to construct a Soviet satellite mission prediction model. Before a Soviet launch occurs, formulations of the model's prior probability distribution allows the input of expert knowledge and any available information. As the predictive variables of the model become known, the information is used to successively refine the estimate of the probable mission, thereby, reducing the uncertainty in the model. Discretizing is used to approximate continuous variables as discrete variables which successfully allows the combination of both variable types in a single influence diagram model. Results of testing and recommendations for continued research are presented. GRA

**N91-20671*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**SHARP: AUTOMATED MONITORING OF SPACECRAFT HEALTH AND STATUS**
David J. Atkinson, Mark L. James, and R. Gaius Martin *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 244-258 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 22A

**N91-20729*#** Space Command, Peterson AFB, CO.
**SMALL SATELLITE DEBRIS CATALOG MAINTENANCE ISSUES**
Phoebe A. Jackson *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and

Research (SOAR 90) Jan. 1991 p 696-704 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 22A

**N91-20730*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**THE IMPORTANCE OF MOMENTUM TRANSFER IN COLLISION-INDUCED BREAKUPS IN LOW EARTH ORBIT**
Robert C. Reynolds and Brian J. Lillie *In its* Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 706-717 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 22A

**N91-20731*#** Naval Space Surveillance System, Dahlgren, VA. Dept. of Analysis and Software.
**NAVSPASUR ORBITAL PROCESSING FOR SATELLITE BREAK-UP EVENTS**
Paul W. Schumacher, Jr. *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 718-723 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 22A

# 13 ASTRODYNAMICS

Includes powered and free-flight trajectories; and orbital and launching dynamics.

**N91-20172#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**REALISTIC ORBITS ABOUT THE MARTIAN MOONS M.S. Thesis**
Samuel R. Bryant Dec. 1990 100 p
(AD-A230473; AFIT/GA/ENY/90D-1) Avail: NTIS HC/MF A05 CSCL 03/3

Orbits about the Martian moons, Phobos and Deimos, previously found to be stable by the Poincare surface of section technique in a restricted three-body system, were investigated with non-zero eccentricity of the moons added to the dynamics of the planar four-body system (Mars, Moon, Sun, and artificial satellite). Although not strictly applicable to this case, the surface of section technique was used to verify whether or not the previously found stable orbits were realistic when a real world perturbation was added to the system dynamics. The surface of section technique involves the numerical integration of several orbits with the same initial value of the Hamiltonian based on matching the angular rates of the orbit and moon with respect to Mars. Apoapsis and periapsis points of the orbits were plotted in the two-dimensional configuration space. Stable orbits were found when the points formed regions which are bounded; chaotic orbits were indicated by random points. GRA

**N91-20173#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**ANALYSIS OF PARKING ORBITS FOR A STS EXTERNAL TANK IN LOW EARTH ORBIT M.S. Thesis**
James E. Cross Nov. 1990 79 p
(AD-A230530; AFIT/GA/ENY/90D-02) Avail: NTIS HC/MF A05 CSCL 22/3

A study was conducted of a single external tank in low earth orbit. Criteria for a parking orbit are then defined. Various orbits are then selected by varying the semi-major axis, eccentricity, and inclination. The resulting equations of motion for each of the above orbits (including atmospheric drag and a 2x0 gravity model) are numerically integrated over a time span of 90 earth days. An examination was made of the lowest initial altitudes which allowed the external tank to remain in the orbit window. GRA

# 14 GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE)

Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and simulators.

For related information see also *09 Research and Support Facilities (Air).*

**N91-20174#** Arnold Engineering Development Center, Arnold Air Force Station, TN.
**SPACE CHAMBERS CONTAMINATION DIAGNOSTICS AND ANALYSIS Final Report, 1 Oct. 1987 - 31 Aug. 1990**
W. D. Williams, R. J. Bryson, W. T. Bertrand, and J. H. Jones Dec. 1990 152 p Prepared in cooperation with Calspan Field Services, Inc., Arnold AFS, TN
(AD-A230248; AEDC-TR-90-18) Avail: NTIS HC/MF A08 CSCL 03/2

In order for the AEDC to meet its requirement to be the Center for Expertise (COE) for space environmental simulation, a technology effort was structured to provide the required enabling technologies. The proper simulation of the space environment in a ground test chamber requires a complete characterization and control of facility, chamber, and test article generated contaminants. To meet these testing requirements, the objectives of this project included the development of the following: (1) laboratory diagnostics support; (2) online diagnostic instrumentation; and (3) computational analysis capability. A laboratory capability was developed to screen materials for contamination potential and to identify unknown contaminants. New diagnostic techniques for more sensitive contaminant mass measurements and particulate cleanliness level measurements were identified. Contamination analysis development included evaluation of codes to simulate molecular flow in test chambers, establishment of a material property database, and installation of library data and algorithms for identification of unknown contaminants by mass spectra searches. GRA

**N91-20175#** Ballistic Research Labs., Aberdeen Proving Ground, MD.
**PLASMA ANALYSIS OF A SMALL-BORE, ARC-ARMATURE RAILGUN Final Report, May 1988 - Dec. 1989**
Alexander E. Zielinski and John D. Powell Nov. 1990 37 p
(AD-A230289; BRL-TR-3175) Avail: NTIS HC/MF A03 CSCL 20/3

Diagnostic measurements of plasma-armature properties have been made on a 9.3-mm square-bore, arc-driven railgun. The measurements include the total current carried by the arc, the voltages across the breech and muzzle ends of the gun tube, light output from the arc seen at points along the gun tube, and finally the time rate of change of the induction field associated with the armature current. From these data it is possible to infer the length of the arc and the current-density distribution within it as a function of time. The aggregate of this information is then used to provide input for a second mathematical model which allows deduction of the armature temperature, ionization state, pressure, and mass. Results of the data analysis are compared with those of one-dimensional steady-state theory and with conclusions from a recent 50-mm square-bore railgun experiment. The dissimilarities between the two experimentally derived results are noted, and possible reasons for those differences discussed. GRA

**N91-20176#** Westinghouse Electric Corp., Pittsburgh, PA.
**EVALUATION OF ELECTROMAGNETIC AND ELECTROTHERMAL LAUNCHERS FOR THE BRL ADVANCED TEST FACILITY Final Report, 17 Aug. 1988 - 16 Aug. 1989**
R. M. DelVecchio, G. Gibson, H. Riemersma, and D. W. Scherbarth Nov. 1990 250 p
(Contract DAAA15-88-C-0012)
(AD-A229661; Rept-89-9E6-EMBRL-R2; BRL-CR-646) Avail: NTIS HC/MF A11 CSCL 14/2

Optimum designs have been developed for three types of

electric launchers that can be used for conducting terminal ballistic research. BRL specified the operational requirements, viz., to accelerate penetrators having a mass in the 60 to 200 g range and a length-to-diameter ratio in the 10 to 40 range to velocities in the 2.5 to 3.5 km/s range. Capacitor-driven electromagnetic launchers (EMLs), homopolar-generator-driven EMLs, and capacitor-driven electrothermal launchers have been evaluated and compared on the basis of technical risks and capital costs. A capacitor-driven EML is recommended as the best option for meeting BRL's requirements. Based on the design of the preferred launcher option, a one-year commissioning/test (C/T) program has been defined. The C/T Program addresses the technical issues that can be identified that impact on facility performance, reliability and cost of operation. The resolution of these issues by the conclusion of the C/T Program will allow routine operation of the facility for terminal ballistic research to commence. At that time, the BRL team should thoroughly understand the operation and maintenance of the advanced gun facility. GRA

**N91-20657*#** Lockheed Engineering and Sciences Co., Houston, TX. Dept. of Simulation Development.
**BERTHING SIMULATOR FOR SPACE STATION AND ORBITER**
Sam Veerasamy *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 120-125 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

**N91-20694*#** Lockheed Space Operations Co., Cocoa Beach, FL.
**RULE-BASED SIMULATION MODELS**
Joseph L. Nieten and Kathleen M. Seraphine *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 424-428 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 14B

# 15 LAUNCH VEHICLES AND SPACE VEHICLES

Includes boosters; operating problems of launch/space vehicle systems; and reusable vehicles.

For related information see also *20 Spacecraft Propulsion and Power.*

**N91-20177*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**BENEFITS FROM SYNERGIES AND ADVANCED TECHNOLOGIES FOR AN ADVANCED-TECHNOLOGY SPACE STATION**
L. Bernard Garrett, Melvin J. Ferebee, Jr., Manuel J. Queijo, and Ansel J. Butterfield (Bionetics Corp., Hampton, VA.) Washington Apr. 1991 25 p
(NASA-TP-3067; L-16618; NAS 1.60:3067) Avail: NTIS HC/MF A03 CSCL 22A

A configuration for a second-generation advanced technology space station has been defined in a series of NASA-sponsored studies. Definitions of subsystems specifically addressed opportunities for beneficial synergistic interactions and those potential synergies and their benefits are identified. One of the more significant synergistic benefits involves the multi-function utilization of water within a large system that generates artificial gravity by rotation. In such a system, water not only provides the necessary crew life support, but also serves as counterrotator mass, as moveable ballast, and as a source for propellant gases. Additionally, the synergistic effects between advanced technology materials, operation at reduced artificial gravity, and lower cabin atmospheric pressure levels show beneficial interactions that can be quantified in terms of reduced mass to orbit. Author

**N91-20679*#** General Dynamics Corp., San Diego, CA. Space Systems Div.
**EXPERT SYSTEM DECISION SUPPORT FOR LOW-COST LAUNCH VEHICLE OPERATIONS**
G. P. Szatkowski and Barry E. Levin *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 304-316 Sponsored in part by AFSD (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 22B

**N91-20681*#** Symbiotics, Inc., Cambridge, MA.
**EXODUS: INTEGRATING INTELLIGENT SYSTEMS FOR LAUNCH OPERATIONS SUPPORT**
Richard M. Adler and Bruce H. Cottman *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 324-330 (For primary document see N91-20641 12-59)
(Contracts NAS10-11606; DAAB10-87-C-0053)
Avail: NTIS HC/MF A21 CSCL 22B

# 16 SPACE TRANSPORTATION

Includes passenger and cargo space transportation, e.g., shuttle operations; and space rescue techniques.

For related information see also *03 Air Transportation and Safety* and *18 Spacecraft Design, Testing and Performance.* For space suits see *54 Man/System Technology and Life Support.*

**N91-20178#** Aerospace Medical Research Labs., Wright-Patterson AFB, OH.
**OPTICAL TEST OF THE SPACE SHUTTLE OVERHEAD WINDOWS Final Report, Aug. 1989 - Apr. 1990**
Harold S. Merkel and Harry L. Task May 1990 43 p
(AD-A229919; AAMRL-TR-90-024) Avail: NTIS HC/MF A03 CSCL 17/5

An optical test of the space shuttle overhead windows was performed to determine how the overhead windows would affect the resolution of in-cabin telescopes such as the Spaceborne Direct-View Optical System (SpaDVOS). The test consisted of four subjects viewing a resolution target through the windows with a telescope composed of the SpaDVOS objective lens and an eyepiece. Data were recorded for three focal lengths, five aperture settings, and nine windows conditions. The results showed the effect of the windows on resolution was not significant at apertures less than approximately two inches. However, the windows did degrade performance for the larger aperture settings. A photographic test and an independent visual test performed by the Aerospace Corporation corroborated these results. GRA

**N91-20661*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**THE DEVELOPMENT TEST FLIGHT OF THE FLIGHT TELEROBOTIC SERVICER**
J. Andary, P. Spidaliere, and R. Sosnay (Martin Marietta Corp., Denver, CO.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 151-158 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 22B

**N91-20734*#** Lockheed Aircraft Corp., Palo Alto, CA. Research and Development Div.
**LABORATORY INVESTIGATION OF VISIBLE SHUTTLE GLOW MECHANISMS**
A. Leone, G. R. Swenson, G. E. Caledonia, and K. W. Holtzclaw (Physical Sciences, Inc., Andover, MA.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 743-751 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 22B

# 17 SPACE COMM., SPACECRAFT COMM., COMMAND & TRACKING

Includes telemetry; space communications networks; astronavigation and guidance; and radio blackout.

For related information see also *04 Aircraft Communications and Navigation* and *32 Communications and Radar.*

**N91-20179#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**AUTONOMOUS NAVIGATION OF A SATELLITE CLUSTER M.S. Thesis**
Stephen C. Johnston Dec. 1990 68 p
(AD-A230683; AFIT/GA/ENY/90D-9) Avail: NTIS HC/MF A04 CSCL 22/3

The relative position determination of a cluster of satellites operating in a low earth orbit is investigated. A U-D Covariance Factorization Kalman Filter is used for the on-board estimator with dynamics based on the Clohessy-Wiltshire equations. Measurements consist of range data between a single host satellite and the remaining cluster. Therefore only relative position and velocity states with respect to the host satellite can be determined. A 15 sample Monte Carlo simulation was conducted with clusters of 2, 5, and 10 satellites, respectively. Performance results consists of average error, average true error and filter covariance as a function of time. GRA

**N91-20180#** European Space Agency, Paris (France). Standards Approval Board for Space Data Communications.
**TELEMETRY CHANNEL CODING STANDARD**
Sep. 1989 39 p
(ESA-PSS-04-103-Issue-1; ISSN-0379-4059; ETN-91-98978)
Copyright Avail: NTIS HC/MF A03

The purpose of this standard is to establish uniform requirements for the implementation of spacecraft telemetry channel coding systems by ESA. To this end the standard: establishes a common framework and provides a common basis for the coding structures of ESA spacecraft projects to proceed coherently with the implementation of spaceborne telemetry systems which are compatible with the ESA ground systems; allows ESA spacecraft projects to proceed coherently with the implementation of spaceborne telemetry systems which are compatible with the ESA ground systems; potentially provides a high level of commonality between both ESA spaceborne and ground based telemetry systems and the ground systems of other CCSDS (Consultative Committee for Space Data Systems) agencies; provides information on the performance of the various telemetry channel coding schemes specified by this standard. ESA

**N91-20181#** European Space Agency, Paris (France). Standards Approval Board for Space Data Communications.
**RANGING STANDARD. VOLUME 1: DIRECT GROUND TO SPACECRAFT RANGING**
Apr. 1990 38 p
(ESA-PSS-04-104-Vol-1-Issue-1; ISSN-0379-4059; ETN-91-98979)
Copyright Avail: NTIS HC/MF A03

The purpose of this standard is to: ensure compatibility between ESA spacecraft TTC (Telemetry, Tracking and Command) transponders and the Range and Doppler Tracking (RDT) facilities of the ESA Earth network; define the compatibility between the agency's spacecraft and other networks with which they may have to work; establish a minimum level of RDT accuracy for missions conforming to this standard; facilitate the early design of flight hardware and ensure that the resulting project interfaces and system performances are compatible with given ESA ranging configurations and specifications. Direct ground to spacecraft ranging is concerned with single access RDT on direct links between spacecraft of category A or category B missions and Earth based stations. This volume is applicable to all ESA spacecraft that are supported for RDT by direct links to ESA-controlled Earth stations operating in the space operations service. Missions that are supported via Data Relay Systems (DRS) and that need, for backup support, direct links to ESA controlled ground stations are not necessarily bound by the requirements set out in this volume of the standard. ESA

# 18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE

Includes satellites; space platforms; space stations; spacecraft systems and components such as thermal and environmental controls; and attitude controls.

For life support systems see *54 Man/System Technology and Life Support.* For related information see also *05 Aircraft Design, Testing and Performance, 39 Structural Mechanics,* and *16 Space Transportation.*

**N91-20182#** Technische Hogeschool, Delft (Netherlands).
**ARCHITECTURE IN SPACE STRUCTURES Ph.D. Thesis**
M. Eekhout 23 May 1989 146 p
(PB91-114868) Avail: NTIS HC/MF A07 CSCL 22B

The term space structures or spatial structures is used in the world of architecture and structural engineering to indicate loadbearing structures that require three-dimensional space to act and to be stable. The vision of a product-architect on all kinds of design aspects of space structures is presented. The aim was to write a broad overview rather than describe aspects of space structures with an inward-looking view. Architecture in the sense of the book is meant as the built environment; it is not an opinion on the quality of these buildings, but rather used as a collection of all buildings with their relationships from simple sheds to high quality architecture. GRA

**N91-20183*#** Arizona State Univ., Tempe. Aerospace Research Center.
**DYNAMICS OF AEROSPACE VEHICLES Final Technical Report, May 1987 - Sep. 1990**
David K. Schmidt 1 Apr. 1991 114 p
(Grant NAG1-758)
(NASA-CR-188015; NAS 1.26:188015) Avail: NTIS HC/MF A06 CSCL 22B

Papers on the following subjects are presented: (1) multivariable flight control synthesis and literal robustness analysis for an aeroelastic vehicles; (2) numerical and literal aeroelastic-vehicle-model reduction for feedback control synthesis; and (3) dynamics of aerospace vehicles. K.S.

**N91-20184*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**DESIGNS FOR THE ATDRSS TRI-BAND REFLECTOR ANTENNA**
Shung-Wu Lee, Martin L. Zimmerman (Illinois Univ., Urbana.), Gene Fujikawa, and G. Richard Sharp 1991 7 p Proposed for presentation at the 1991 IEEE AP-S International Symposium and URSI Radio Science Meeting, London, Ontario, 24-28 Jun. 1991
(NASA-TM-103754; E-6008; NAS 1.15:103754) Avail: NTIS HC/MF A02 CSCL 20N

Two approaches to design a tri-band reflector antenna for the Advanced TDRSS are examined. Two reflector antenna configurations utilizing frequency selective surfaces for operation in three frequency bands, S, Ku, and Ka, are proposed. Far-field patterns and the antenna feed losses were computed for each configuration. An offset-fed single reflector antenna configuration was adapted for conceptual spacecraft design. CADAM drawings were completed and a 1/13th scale model of the spacecraft was constructed. Author

**N91-20185#** Qualcomm, Inc., San Diego, CA.
**AFFORDABLE TACTICAL LOW ALTITUDE SATELLITE TECHNOLOGY TASK Final Report, Nov. 1987 - Apr. 1990**
Rich P. Kosowsky Nov. 1990 36 p
(Contract F30602-88-C-0012)
(AD-A229997; RADC-TR-90-273) Avail: NTIS HC/MF A03 CSCL 22/2

The Affordable Tactical Low Altitude Satellite Technology (ATLAST) program focuses on developing an architecture for a system providing tactical and beyond line-of-sight communications employing a constellation of satellites in Low Earth Orbit (LEO). A LEO based approach may result in a cost effective system providing voice and data communications between small, low-power, mobile terminals and hub stations. A constellation of small, inexpensive, lightweight satellites can be launched into LEO at a cost lower than that for higher orbits. Also, using LEO assets requires much less power to close the link. The approach is presented to designing such a system and the design is summarized. The initial communications requirements are presented, and the impact discussed. Trade-off involving geometries for tactical links are presented. The baseline strawman design is given, including communications link budgets. GRA

**N91-20186#** Systems Science and Software, La Jolla, CA.
**POLAR CODE VALIDATION Final Report, 6 May 1986 - 6 Sep. 1989**
I. Katz, J. R. Lilley, Jr., Gary A. Jongeward, M. J. Mandell, and T. T. Luu 30 Sep. 1989 56 p
(Contract F19628-86-C-0056)
(AD-A230138; SSS-DFR-89-10708/R1; GL-TR-89-0276) Avail: NTIS HC/MF A04 CSCL 22/2

The POLAR code was written to model charging by large spacecraft in low, polar orbit. This report documents comparisons of POLAR code calculations with flight experiments. Calculations of the plasma wake behind the Shuttle Orbiter are compared with the situ measurements of Murphy et al., 1989. Calculation of the charging of DMSP-7 are compared with the flight measurements of Gussenhoven et al., 1985. Calculations of current and potential on the SPEAR 1 rocket are compared with the flight measurements. Calculation of electron collection by the CHARGE 2 mother rocket payload are compared with flight observations. In all cases, the POLAR calculations agreed with the essential features of the observations. GRA

**N91-20187#** Arnold Engineering Development Center, Arnold Air Force Station, TN.
**CONTAMINATION EFFECTS OF SATELLITE MATERIAL OUTGASSING PRODUCTS ON THERMAL SURFACES AND SOLAR CELLS Final Report, 1 Oct. 1988 - 30 Sep. 1990**
B. L. Seiber, W. T. Bertrand, and B. E. Wood Dec. 1990 57 p
(AD-A230199; AEDC-TR-90-27) Avail: NTIS HC/MF A04 CSCL 10/3

The Wright Research and Development Center (WRDC) and the Arnold Engineering Development Center (AEDC) have initiated a program for measuring optical and radiative effects of satellite material outgassing products on thermal control and cryo-optic surfaces. A solar absorptance chamber for making reflectance/absorptance measurements on thermal control materials has been established. This report describes the operation of the solar absorptance chamber used to measure the degradation of reflective surfaces and solar cells caused by deposition of outgassing contaminants. The effects of solar irradiation (UV) were also studied, and results are presented. Data are presented for Dow Corning 93-500 Space-grade encapsulant (DC93-500), Furane Products Uralane 5753-A/B(LV) encapsulant, and Polyclad FR-4 Epoxy laminate. GRA

**N91-20188#** Ohio State Univ., Columbus. Dept. of Aeronautical and Astronautical Engineering.
**A THEORETICAL APPROACH TO ANALYSIS AND DESIGN OF EFFICIENT REDUCED CONTROL FOR SPACE STRUCTURES Final Report, Oct. 1986 - Oct. 1990**
Hayrani Oz Oct. 1990 270 p
(AD-A230223; WRDC-TR-90-3027) Avail: NTIS HC/MF A12 CSCL 12/9

The report develops concepts of efficiency for the control of structural dynamic systems. The efficiencies defined are unique nondimensional measures of structure control system performance forming a common basis of evaluation of such systems. Developments are presented both for distributed parameter systems and spatially discrete, typically finite element models of structural control systems are given by developing an efficiency modes analysis of controllers. The significance of relationship of controller efficiency modes to structural modes is studied. Based on these concepts, efficient model/controller reduction approaches are developed. The efficiencies of systems with dynamic compensators including reduced order efficiency-state estimators are also developed. Illustrative examples based on the ACOSS-4 tetrahedral structure and the CSDL-ACOSS-6 (Model 2) as typical large space structures, are given. The research establishes that efficiency of structural control systems is a fundamental concept that must be addressed in any structure control system design. The efficiency measures also establish the performance of infinity-dimensional systems on the basis of finite dimensional control design models. GRA

**N91-20189*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**UTILIZATION OF COMMON PRESSURIZED MODULES ON THE SPACE STATION FREEDOM**
Marston J. Gould, Michael L. Heck, and Daniel D. Mazanek (Analytical Mechanics Associates, Inc., Hampton, VA.) Jan. 1991 90 p
(NASA-TM-102779; NAS 1.15:102779) Avail: NTIS HC/MF A05 CSCL 22B

During the preliminary design review of Space Station Freedom elements and subsystems, it was shown that reductions of cost, weight, and on-orbit integration and verification would be necessary in order to meet program constraints, particularly nominal Orbiter payload launch capability. At that time, the Baseline station consisted of four resource nodes and two 44 ft modules. In this study, the viability of a common module which maintains crew and payload accommodation is assessed. The size, transportation, and orientation of modules and the accommodation of system racks and user experiments are considered and compared to baseline. Based on available weight estimates, a module pattern consisting of six 28 ft. common elements with three radial and two end ports is shown to be nearly optimal. Advantageous characteristics include a reduction in assembly flights, dual egress from all elements, logical functional allocation, no adverse impacts to international partners, favorable airlock, cupola, ACRV (Assured Crew Return Vehicle), and logistics module accommodation, and desirable flight attitude and control characteristics. Author

**N91-20190#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**NONLINEAR ANALYSIS OF A SPINNING SYMMETRIC SATELLITE IN AN ELLIPTICAL ORBIT M.S. Thesis**
Michael Ulisse Dec. 1990 158 p
(AD-A230463; AFIT/GA/ENY/90D-13) Avail: NTIS HC/MF A08 CSCL 22/3

Controlled and uncontrolled equations of motion for a spinning symmetric satellite in an elliptical orbit are analysed using Floquet theory, Poincare maps, and continuation. The equations of motion for the uncontrolled system are derived via energy methods. A simple feedback controller design and one based on Floquet theory are presented. Parameters varied in the equations of motion include the spin about the symmetry axis of the satellite, the inertia ratio of the satellite, the eccentricity of the orbit, and the controller gains. Floquet analyses determine local stability and bifurcation points. Poincare maps exhibit some interesting and complex structure in the global phase space. Continuation using a bifurcation analysis computer code (AUTO) reveals a sequence of period doublings, which is verified via numerical integration, for the simple rate feedback controller. The onset of chaotic motion is detected for this sequence of period doublings. GRA

**N91-20191#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**PROPOSED DESIGN OF A TACTICAL RECONNAISSANCE SATELLITE SYSTEM M.S. Thesis**
John D. Severance Dec. 1990 87 p

(AD-A230471; AFIT/GSO/ENS/90D-16) Avail: NTIS HC/MF A05 CSCL 15/4

Tactical reconnaissance is a much needed wartime asset, yet with the deactivation of all active-duty RF-4C squadrons world-wide there appears to be a gap in this country's war-fighting capability. This study proposes a system which utilizes a constellation of small tactical satellites and mobile ground receiving stations that can fulfill the tactical reconnaissance mission. A literature review gives background information on resolution variables, the RF-4C, space reconnaissance, and sensing technologies. After defining system requirements and constraints, a basic system concept is determined. Three alternative systems, separated mostly by threat scenario, technology, and cost, are evaluated using Athey's Systematic Systems Approach. The selected satellite's sensors consist of a multispectral imager and a SAR. The satellite will be launched by the Pegasus air-launch booster for flexibility, survivability, and responsiveness. Initially, four satellites will be placed in a circular LEO for training with four more in-orbit spares, although, twelve more will be stored as ground spares and can be placed into any LEO that is needed. the ground receiving unit will be Mark IVB tactical terminal which will be located in communications vans at the lowest echelon with a planning staff wherever troops are deployed. GRA

**N91-20192#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.

**MOVING-BANK MULTIPLE MODEL ADAPTIVE ESTIMATION AND CONTROL APPLIED TO A LARGE FLEXIBLE SPACE STRUCTURE M.S. Thesis**

Robert B. Moyle Dec. 1990 234 p

(AD-A230515; AFIT/GE/ENG/90D-45) Avail: NTIS HC/MF A11 CSCL 22/2

The performance of moving-bank multiple model adaptive estimation (MMAE) and control (MMAC) algorithms for large space structure control is analyzed in this thesis. The performance of a six-state filter model and associated controller are evaluated on the basis of estimation/control performance against a 24-estate truth model. A model developed using finite element analysis is used to approximate a large flexible space structure. The space structure is configured as a two-bay truss which is attached to a large central hub, where the mass of the hub is considered to be much more larger than the mass of the flexible structure. The model is developed in physical coordinates and then transformed into modal coordinates, where the method of singular perturbations is used to obtain a reduced order filter model. The actual positions and velocities of various physical points on the structure are used in the evaluation of the moving-bank algorithm performance. Results of the research indicate that appropriate determination of the filter model noise statistics as well as the LQG controller weighting matrices significantly improve performance of the bank throughout the parameter space. The results indicate that the performance of the moving-bank algorithms is seriously degraded by the inclusion of the filter-computed residual covariance in the conditional probability density function for computation of the hypothesis conditional probabilities within the multiple model algorithms. GRA

**N91-20193#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**MODEL-BASED REASONING IN THE DETECTION OF SATELLITE ANOMALIES M.S. Thesis**

Ralph W. Dries Dec. 1990 221 p

(AD-A230535; AFIT/GSO/ENG/90D-03) Avail: NTIS HC/MF A10 CSCL 12/9

Automatic fault detection and recovery would be a mandatory requirement for a satellite where some degree of autonomy is required. Some AI techniques are reviewed which are used for the detection of satellite anomalies, and concludes that the model based reasoning paradigm is best suited for automated on-board fault detection because it can cope with situations not necessarily programmed into the knowledge base. Using the Scheme language and its SCOOPS object oriented extension, development of software is described that models the pitch control channel in the attitude and velocity control subsystem of a typical geo-stationary communications satellite. This model is used by the model based reasoning algorithm to diagnose faults in the real system. The algorithm used, is based on Scarl's Full Consistency Algorithm, which is suitable for systems that have many sensors, but has limitations when applied to systems that are dependent on time or have feedback loops. These limitations were overcome by using a model that did not include time dependent objects and by breaking the loop. It was found, for this problem domain, that the reasoner's model did not have to be identical to the real system to be able to successfully detect the cause of an anomaly. GRA

**N91-20194#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.

**INVESTIGATION OF DIRECT AND INDIRECT OPTIMIZATION ALGORITHMS FOR AEROSPACE STRUCTURES M.S. Thesis**

Harry Hopkins Dec. 1990 93 p

(AD-A230549; AFIT/GA/ENY/90D-7) Avail: NTIS HC/MF A05 CSCL 22/1

This thesis investigated the performance of two direct and two indirect methods of structural optimization. A gradient calculator and overall design system was created with the finite element code FRAME. Three of the methods were employed using this system with the fourth being a commercial available code. The algorithms were applied to two different sized trusses using static constraints and were measured for accuracy, reliability, and efficiency. Results for the problems tested showed the Direct methods were sensitive to starting designs and their performance depended on the proper selection of internal parameters. They were also shown to have a high degree of accuracy and the flexibility to handle different problems. The indirect methods showed that they were very effective when applied to specific problems and were simpler to implement and manage than direct methods, but lacked the flexibility to handle a variety of problems. GRA

**N91-20195#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**A CORRELATION AND FORECASTING ANALYSIS ON LOST SATELLITES M.S. Thesis**

Kenneth R. Norton Dec. 1990 108 p

(AD-A230585; AFIT/GSO/ENS/90D-13) Avail: NTIS HC/MF A06 CSCL 22/2

The relationship between the size of the United States Air Force Space Command's lost satellite lists and thirteen other variables is investigated. The thirteen variables contain the Space Surveillance Center crew's effort to work the lost list, solar activity, geomagnetic field strength, and the number of observations received each day from seven space track sensors. To identify the relationship of cause and effect between the lost lists and the thirteen variables, simple and multiple linear regressions are used on a data set that begins on 1 January 1988 and ends on 31 December 1988. Multiple linear regression and basic time-series smoothing techniques are used to forecast the number of lost satellites. The results of this study show that solar activity causes near earth satellites to 'go lost'. This study also shows that not all sensors respond to increases in the size of lost lists in the same manner. Finally, the best forecast for the size of the lost satellite lists is provided by a multiple linear regression. GRA

**N91-20196#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**DEVELOPMENT OF AN IMAGE REGISTRATION TECHNIQUE FOR POLAR-ORBITING SATELLITES M.S. Thesis**

Jerry L. Mehlberg Dec. 1990 90 p

(AD-A230586; AFIT/GSO/ENS/90D-12) Avail: NTIS HC/MF A05 CSCL 22/3

In this thesis, a means to perform spatial registration (gridding) of meteorological satellite data is developed. It is applicable to Automatic Picture Transmission (APT) data from the TIROS-N series polar-orbiting satellites operated by the National Oceanic and Atmospheric Administration (NOAA). This technique does not require the use of ground control points. Registration is accomplished using an advanced orbital model to precisely

compute the satellite's location based on NORAD two-line element sets and the time of the image. This technique is examined for accuracy and sensitivity to errors in the element set and satellite attitude control. This study involves over 70 images over a 60-day period. GRA

**N91-20197#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**MEASURING THE EFFECTIVENESS OF SPACE: SATELLITE WEATHER SYSTEMS M.S. Thesis**
Steven T. Wilson Dec. 1990 140 p
(AD-A230590; AFIT/GSO/ENS/90D-18) Avail: NTIS HC/MF A07 CSCL 22/3

Using concepts from multivariate utility theory, basic orbital mechanics, and information regarding operational and planned meteorological satellites, this thesis develops a meaningful MOE to support high-level decision making regarding the allocation, acquisition, and operational deployment of space meteorological satellite (METSAT) assets. Satellite meteorological systems were chosen because of the ready availability of pertinent unclassified data. However, the methodology presented may be applied to any type of space system. GRA

**N91-20198#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**MULTIDISCIPLINARY MODELING AND DESIGN OF A SPACE STRUCTURE M.S. Thesis**
Brian K. Cassiday, Lawrence L. Gatschet, John T. Tester, Stephen O. Gaines, II, and Mario N. Moya Dec. 1990 263 p
(AD-A230626; AFIT/GSE/ENY/90D-1) Avail: NTIS HC/MF A12 CSCL 05/1

A method is needed to simultaneously integrate several engineering disciplines into one complete model to determine the performance of the system as a whole during the design development. System engineering methodologies are particularly suited to this problem. These methods provide a structured approach to problem formulation and system parameter identification. Bond graphs are also well suited as bond graphs model power flow and energy relationships within subsystems, a characteristic inherent to all dynamic systems. The intent was to demonstrate the use of concurrent engineering theory to systematically model a large flexible space structure involving several engineering disciplines. The disciplines considered include: dynamics, controls, optics, structures, and heat transfer. A set of optimal solutions is presented and the results of this research are compared and contrasted with the results from classical design and modelling techniques. GRA

**N91-20199#** Massachusetts Inst. of Tech., Cambridge. Lincoln Lab.
**UHF POLARIZATION CHARACTERISTICS OF LES-8/9**
W. W. Ward and C. A. Lindberg 7 Nov. 1990 24 p
(Contract F19628-90-C-0002)
(AD-A230733; TR-897; ESD-TR-90-111) Avail: NTIS HC/MF A03 CSCL 22/2

Lincoln Experimental Satellites 8 and 9 (LES-8/9) were launched together in 1976. On-orbit test made shortly after launch indicated that their UHF communications systems were working properly. In particular, the RHCP characteristics of their UHF antenna systems on orbit were found to be close to those measured before launch. Several years after launch, however, a user of LES-8/9 UHF functions found discrepancies at some frequencies between the test data and what was expected to be observed, based on RHCP antenna characteristics. Subsequent measurements made at Lincoln Laboratory indicated that the UHF antenna system of LES-8 has changed in its polarization characteristics. It is nearly linearly polarized at some frequencies. A possible cause for this failure has been deduced and is presented. So far as is known, LES-9 remains unaffected in this regard. GRA

**N91-20200#** Massachusetts Inst. of Tech., Cambridge. Lincoln Lab.
**ON THE CALCULATION OF ACCURATE ANTENNA POINTING FOR TERMINALS WORKING WITH GEOSYNCHRONOUS COMMUNICATIONS SATELLITES**
M. T. Lane 11 Dec. 1990 28 p
(Contract F19628-90-C-0002)
(AD-A230734; TR-906; ESD-TR-90-137) Avail: NTIS HC/MF A03 CSCL 25/5

Terminals working with communications satellites must have the capability to produce accurate antenna pointing from information provided by the operations center. Usually it takes the form of an (mean) element set for the satellite orbit, which must be propagated by the terminals and from which pointing must be calculated. This report addresses the problem for geosynchronous communications satellites, most non-Soviet communications satellites being in such orbits. First the nature of geosynchronous orbit propagation is summarized, with principal perturbations highlighted, and then the problem of element set transfer is discussed from a practical point of view. Since most operations centers do not maintain element sets for their satellites (but rather receive ephemeris information from another source), this discussion is designed to maximize the accuracy and lifetime of a transferred element set. An example is provided to demonstrate the need for compatible element sets and software, and to show a solution to a timely problem involving element set transfer. GRA

**N91-20201*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**A NEW METHOD FOR DETERMINING WHICH STARS ARE NEAR A STAR SENSOR FIELD-OF-VIEW**
Russell E. Yates, Jr. and John D. Vedder (McDonnell-Douglas Space Systems Co., Houston, TX.) Feb. 1991 13 p
(NASA-TM-102180; S-631; NAS 1.15:102180) Avail: NTIS HC/MF A03 CSCL 22B

A new method is described for determining which stars in a navigation star catalog are near a star sensor field of view (FOV). This method assumes that an estimate of spacecraft inertial attitude is known. Vector component ranges for the star sensor FOV are computed, so that stars whose vector components lie within these ranges are near the star sensor FOV. This method requires no presorting of the navigation star catalog, and is more efficient than tradition methods. Author

**N91-20202*#** Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
**A ROBUST MOMENTUM MANAGEMENT AND ATTITUDE CONTROL SYSTEM FOR THE SPACE STATION**
J. L. Speyer and Ihnseok Rhee (California Univ., Los Angeles.) 1991 41 p
(Contract NCC9-16)
(NASA-CR-188115; NAS 1.26:188115) Avail: NTIS HC/MF A03 CSCL 22B

A game theoretic controller is synthesized for momentum management and attitude control of the Space Station in the presence of uncertainties in the moments of inertia. Full state information is assumed since attitude rates are assumed to be very assurately measured. By an input-output decomposition of the uncertainty in the system matrices, the parameter uncertainties in the dynamic system are represented as an unknown gain associated with an internal feedback loop (IFL). The input and output matrices associated with the IFL form directions through which the uncertain parameters affect system response. If the quadratic form of the IFL output augments the cost criterion, then enhanced parameter robustness is anticipated. By considering the input and the input disturbance from the IFL as two noncooperative players, a linear-quadratic differential game is constructed. The solution in the form of a linear controller is used for synthesis. Inclusion of the external disturbance torques results in a dynamic feedback controller which consists of conventional PID (proportional integral derivative) control and cyclic disturbance rejection filters. It is shown that the game theoretic design allows large variations in the inertias in directions of importance. Author

**N91-20148*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**MANUAL CONTROL ASPECTS OF ORBITAL FLIGHT Abstract Only**
Adam R. Brody (Sterling Software, Palo Alto, CA.) *In its* Manual Control Aspects of Orbital Flight Dec. 1990 p 2 (For primary document see N91-20147 12-12)
Avail: NTIS HC/MF A03 CSCL 22B

**N91-20149*#** Rockwell International Corp., Houston, TX. Space Operations.
**ORBITAL MANEUVERING VEHICLE REMOTE PILOTING OPERATIONS Abstract Only**
Michael L. Veres *In* NASA, Ames Research Center, Manual Control Aspects of Orbital Flight Dec. 1990 p 3 (For primary document see N91-20147 12-12)
Avail: NTIS HC/MF A03 CSCL 22B

**N91-20150*#** Martin Marietta Corp., Denver, CO. Astronautics Group.
**RESULTS FROM TELEOPERATED FREE-FLYING SPACECRAFT SIMULATIONS IN THE MARTIN MARIETTA SPACE OPERATIONS SIMULATOR LAB Abstract Only**
Craig S. Hartley *In* NASA, Ames Research Center, Manual Control Aspects of Orbital Flight Dec. 1990 p 4 (For primary document see N91-20147 12-12)
Avail: NTIS HC/MF A03 CSCL 22B

**N91-20151*#** McDonnell-Douglas Space Systems Co., Huntington Beach, CA.
**A MANNED MANEUVERING UNIT PROXIMITY OPERATIONS PLANNING AND FLIGHT GUIDANCE DISPLAY AND CONTROL SYSTEM Abstract Only**
Gary R. Gershzohn, Robert J. Sirko, K. Zimmerman, and A. D. Jones *In* NASA, Ames Research Center, Manual Control Aspects of Orbital Flight Dec. 1990 p 5 (For primary document see N91-20147 12-12)
Avail: NTIS HC/MF A03 CSCL 22B

**N91-20155#** Joint Publications Research Service, Arlington, VA.
**DEVELOPMENT, FUNCTIONS OF KVANT-2 SUPPLEMENTARY EQUIPMENT MODULE**
M. M. Lemelev *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 8-16 Transl. into ENGLISH from Zemlya i Vselennaya (Moscow, USSR), no. 3, May - Jun. 1990 p 3-11 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

**N91-20664*#** Lockheed Engineering and Sciences Co., Houston, TX.
**SPACE STATION FREEDOM COUPLING TASKS: AN EVALUATION OF THEIR SPACE OPERATIONAL COMPATIBILITY**
Carlos E. Sampaio, John M. Bierschwale, Terence F. Fleming, and Mark A. Stuart *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 179-183 (For primary document see N91-20641 12-59)
(Contract NAS9-17900)
Avail: NTIS HC/MF A21 CSCL 22B

**N91-20690*#** Boeing Computer Services Co., Huntsville, AL. Artificial Intelligence Center.
**A KNOWLEDGE-BASED APPROACH TO CONFIGURATION LAYOUT, JUSTIFICATION, AND DOCUMENTATION**
F. G. Craig, D. E. Cutts, T. R. Fennel, C. M. Case, and J. R. Palmer (Boeing Aerospace and Electronics Co., Huntsville, AL.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 393-396 Previously announced in IAA as A90-27286 (For primary document see N91-20641 12-59)
Copyright Avail: NTIS HC/MF A21 CSCL 12A

**N91-20696*#** New Mexico Univ., Albuquerque. Dept. of Civil Engineering.
**ASSESSING DAMPING UNCERTAINTY IN SPACE STRUCTURES WITH FUZZY SETS**
Timothy J. Ross and Timothy K. Hasselman (Engineering Mechanics Association, Inc., Torrance, CA.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 442-448 (For primary document see N91-20641 12-59)
(Contract NAS7-1020)
Avail: NTIS HC/MF A21 CSCL 22B

**N91-20705*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**UTILIZING EXPERT SYSTEMS FOR SATELLITE MONITORING AND CONTROL**
Peter M. Hughes *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 493-498 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 22B

**N91-20714*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**RECOVERY FROM AN ANOMALOUS THRUSTER INPUT DURING A SIMULATED DOCKING MANEUVER**
Adam R. Brody (Sterling Software, Moffett Field, CA.) and Stephen R. Ellis *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 557-560 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 22B

**N91-20717*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**MICROGRAVITY CURSOR CONTROL DEVICE EVALUATION FOR SPACE STATION FREEDOM WORKSTATIONS**
Susan Adam, Kritina L. Holden, Douglas Gillan (Lockheed Engineering and Sciences Co., Houston, TX.), and Marianne Rudisill *In its* Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 582-587 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 22B

**N91-20726*#** Air Force Geophysics Lab., Hanscom AFB, MA. Space Physics Div.
**PHOTOMETRIC ANALYSIS OF A SPACE SHUTTLE WATER VENTING**
R. A. Viereck, E. Murad, C. P. Pike, I. L. Kofsky, C. A. Trowbridge, D. L. A. Rall, A. Satayesh, A. Berk, and J. B. Elgin (Spectral Sciences, Inc., Burlington, MA.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 676-680 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 22B

**N91-20727*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**THE ENVIRONMENT WORKBENCH: A DESIGN TOOL FOR SPACE STATION FREEDOM**
Gary A. Jongeward, Robert A. Kuharski, Thomas V. Rankin, Katherine G. Wilcox (Systems Science and Software, La Jolla, CA.), and James C. Roche *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 684-687 (For primary document see N91-20702 12-59)
(Contract NAS3-25347)
Avail: NTIS HC/MF A14 CSCL 22B

**N91-20728*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**FINDINGS OF THE JOINT WORKSHOP ON EVALUATION OF IMPACTS OF SPACE STATION FREEDOM GROUND CONFIGURATIONS**

Dale C. Ferguson, David B. Snyder, and Ralph Carruth (National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 689-694 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 22B

# 19 SPACECRAFT INSTRUMENTATION

For related information see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography.*

No abstracts in this category.

# 20 SPACECRAFT PROPULSION AND POWER

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxilliary power sources.

For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels, 44 Energy Production and Conversion,* and *15 Launch Vehicles and Space Vehicles.*

**N91-20203*#** Thiokol Corp., Brigham City, UT. Space Operations.
**RSRM-11 (36OW011) BALLISTICS MASS PROPERTIES (STS-35) Final Report**
B. J. Hutchinson, L. P. Gruet, and M. C. Richards 21 Jan. 1991 35 p
(Contract NAS8-30490)
(NASA-CR-184107; NAS 1.26:184107; TWR-17550-10) Avail: NTIS HC/MF A03 CSCL 21H

The propulsion performance and reconstructed mass properties data from Thiolol's RSRM-11 motors which were assigned to the STS-35 launch are contained. The Thiokol manufacturing designations for the motors were 360W011A/360W011B, which are referred to as RSRM-11A and RSRM-B, respectively. The launch of STS-35 occurred on 2 December 1990 at the Eastern Test Range (ETR). The data contained herein was input to the STS-35 Flight Evaluation Report. The SRM propellant, TP-H1148, is a composite type solid propellants, formulated of polybutediene acrylic acid, acryonitrile terpolymer binder, epoxy curing agent, ammonium perchlorate oxidizer, and aluminum powder fuel. A small amount of burning rate catalyst (iron oxide) was added to achieve the desired propellant burn rate. The propellant evaluation and raw material information for the RSRM-11 are included. The ballistic performance presented was based on the Operational Flight Instrumentation (OFI) 12.5 sample per second pressure data for the steady state and tail off portion of the pressure trace. Recent studies have shown that the transducers are affected by the measuring system at KSC and temperature gradients created by the igniter heaters. Therefore, an adjustment to the data from each transducer is made to make the initial reading match the atmospheric pressure at the time of launch. Author

**N91-20204*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**EFFECTS OF DUST ACCUMULATION AND REMOVAL ON RADIATORS SURFACES ON MARS**
James R. Gaier, Marla E. Perez-Davis, Sharon K. Rutledge, Deborah Hotes, and Raymond M. Olle (Cleveland State Univ., OH.) Jan. 1991 10 p Presented at the 8th Symposium on Space Nuclear Power Systems, Albuquerque, NM, 6-10 Jan. 1991; sponsored by NASA, New Mexico Univ., Strategic Defense Initiative Organization, DOE, and the AF
(Contract NCC3-19)
(NASA-TM-103704; E-5841; NAS 1.15:103704) Avail: NTIS HC/MF A02 CSCL 10B

Tests were carried out to assess the impact of wind blown dust accumulation and abrasion on radiator surfaces on Mars. High emittance arc-textured copper and niobium-1 percent-zirconium samples were subjected to basaltic dust laden wind at Martian pressure (1000 Pa) at speeds varying from 19 to 97 m/s in the Martian Surface Wind Tunnel. The effect of accumulated dust was also observed by pre-dusting some of the samples before the test. Radiator degradation was determined by measuring the change in the emittance after dust was deposited and/or removed. The principle mode of degradation was abrasion. Arc textured Nb-1 percent-Zr proved to be more susceptible to degradation than Cu, and pre-dusting appeared to have lessened the abrasion. Author

**N91-20205*#** Alabama Univ., Huntsville. College of Engineering.
**ENGINE DATA INTERPRETATION SYSTEM (EDIS) Final Report, 17 Oct. 1989 - 16 Jul. 1990**
Thomas L. Cost and Martin O. Hofmann Jul. 1990 121 p
(Contract NAS8-36955)
(NASA-CR-188061; NAS 1.26:188061; UAH-RR-ME-90-101)
Avail: NTIS HC/MF A06 CSCL 21H

A prototype of an expert system was developed which applies qualitative or model-based reasoning to the task of post-test analysis and diagnosis of data resulting from a rocket engine firing. A combined component-based and process theory approach is adopted as the basis for system modeling. Such an approach provides a framework for explaining both normal and deviant system behavior in terms of individual component functionality. The diagnosis function is applied to digitized sensor time-histories generated during engine firings. The generic system is applicable to any liquid rocket engine but was adapted specifically in this work to the Space Shuttle Main Engine (SSME). The system is applied to idealized data resulting from turbomachinery malfunction in the SSME. Author

**N91-20206*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**COMPUTER CODE FOR SINGLE-POINT THERMODYNAMIC ANALYSIS OF HYDROGEN/OXYGEN EXPANDER-CYCLE ROCKET ENGINES**
Arthur J. Glassman (Toledo Univ., OH.) and Scott M. Jones Washington Apr. 1991 19 p
(NASA-TM-4275; E-5652; NAS 1.15:4275) Avail: NTIS HC/MF A03 CSCL 21H

This analysis and this computer code apply to full, split, and dual expander cycles. Heat regeneration from the turbine exhaust to the pump exhaust is allowed. The combustion process is modeled as one of chemical equilibrium in an infinite-area or a finite-area combustor. Gas composition in the nozzle may be either equilibrium or frozen during expansion. This report, which serves as a users guide for the computer code, describes the system, the analysis methodology, and the program input and output. Sample calculations are included to show effects of key variables such as nozzle area ratio and oxidizer-to-fuel mass ratio. Author

**N91-20678*#** Decision-Science Applications, Inc., Arlington, VA.
**AN INTELLIGENT VALUE-DRIVEN SCHEDULING SYSTEM FOR SPACE STATION FREEDOM WITH SPECIAL EMPHASIS ON THE ELECTRIC POWER SYSTEM**
Joseph C. Krupp *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 296-300 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 10B

**N91-20685*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**AUGMENTATION OF THE SPACE STATION MODULE POWER MANAGEMENT AND DISTRIBUTION BREADBOARD**

Bryan Walls, David K. Hall, and Louis F. Lollar *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 355-359 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 10B

**N91-20689*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**AUTONOMOUS POWER EXPERT SYSTEM ADVANCED DEVELOPMENT**
Todd M. Quinn (Sverdrup Technology, Inc., Brook Park, OH.) and Jerry L. Walters *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 383-390 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 10B

**N91-20724*#** Sverdrup Technology, Inc., Brook Park, OH.
**THE SOLAR ARRAY MODULE PLASMA INTERACTIONS EXPERIMENT (SAMPIE): A SHUTTLE-BASED PLASMA INTERACTION EXPERIMENT**
G. Barry Hillard *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 655-662 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 10A

# 23 CHEMISTRY AND MATERIALS (GENERAL)

**N91-20207*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**NATIONAL EDUCATORS' WORKSHOP: UPDATE 1988. STANDARD EXPERIMENTS IN ENGINEERING MATERIALS SCIENCE AND TECHNOLOGY**
James E. Gardner, comp. and James A. Jacobs, comp. (Norfolk State Univ., VA.) Washington Jan. 1990 83 p Workshop held in Gaithersburg, MD, 10-12 May 1988; sponsored by NASA, Washington and NIST, Gaithersburg, MD
(Grant NAG1-976)
(NASA-CP-3060; L-16732; NAS 1.55:3060) Avail: NTIS HC/MF A05 CSCL 07C

Presented here is a collection of experiments presented and demonstrated at the National Educators' Workshop: Update 88, held May 10 to 12, 1988 at the National Institute of Standards and Technology (NIST), Gaithersberg, Maryland. The experiments related to the nature and properties of engineering materials and provided information to assist in teaching about materials in the education community. For individual titles, see N91-20208 through N91-20223.

**N91-20208*#** National Inst. of Standards and Technology, Gaithersburg, MD. Inst. for Materials Science and Engineering.
**HIGH T(SUB c) SUPERCONDUCTORS: ARE THEY MAGNETIC** **c76**
Robert D. Shull *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 1-5 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 20L

The objective is to demonstrate the magnetic characteristics of the new superconducting oxides with transition temperatures above liquid nitrogen temperature (77 K). The first task was to find out whether YBa2Cu3O7-x is magnetic at liquid nitrogen temperature, and if so, what the sign of its magnetic susceptibility is. Details of the experimental procedure are given. Author

**N91-20209*#** New York City Technical Coll., Brooklyn, NY.
**FLUORESCENT PENETRANT INSPECTION** **c38**
Sankar Sastri *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 7 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 14D

The purpose of this experiment is to familiarize the student with fluorescent penetrant inspection and to relate it to classification of various defects. The penetrant method of nondestructive testing is a method for finding discontinuities open to the surface in solids and essentially nonporous bodies. The method employs a penetrating liquid which is applied over the surface and enters the discontinuity or crack. After the excess of penetrant has been cleaned from the surface, the penetrant which exudes or is drawn back out of the crack indicates the presence and location of a discontinuity. The experimental procedure is described. Author

**N91-20210*#** New York City Technical Coll., Brooklyn, NY.
**MAGNETIC PARTICLE INSPECTION** **c39**
Sankar Sastri *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 9 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 20K

The purpose of this experiment is to familiarize the student with magnetic particle inspection and relate it to classification of various defects. Magnetic particle inspection is a method of detecting the presence of cracks, laps, tears, inclusions, and similar discontinuities in ferromagnetic materials such as iron and steel. This method will most clearly show defects that are perpendicular to the magnetic field. The Magnaglo method uses a liquid which is sprayed on the workpiece to be inspected, and the part is magnetized at the same time. The workpiece is then viewed under a black light, and the presence of discontinuity is shown by the formation of a bright indication formed by the magnetic particles over the discontinuity. The equipment and experimental procedures are described. Author

**N91-20211*#** New York City Technical Coll., Brooklyn, NY.
**RADIOGRAPHIC INSPECTION** **c38**
Sankar Sastri *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 11-12 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 14D

This experiment has several objectives which will familiarize the students with the use of a radiographic inspection system, the method of taking a radiograph, darkroom developing procedures, and inspection of a radiograph. The equipment consists of a Faxitron model 8075 radiographic inspection system. Detailed step-by-step procedures are described. Author

**N91-20212*#** Rame-Hart, Inc., Mountain Lakes, NJ.
**CONTACT ANGLE DETERMINATION PROCEDURE AND DETECTION OF AN INVISIBLE SURFACE FILM** **c25**
G. Meyer and R. Grat *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 13-26 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 07D

The contact angle value, i.e., the tangent angle of liquid resting on a planar solid surface, is a basic parameter which can be applied to a wide range of applications. The goal is to provide a basic understanding of the contact angle measurement technique and to present a simple illustration that can be applied as a quality control method; namely, detection of a surface contaminant which exists on a surface that appears clean to the unaided eye. The equipment and experimental procedures are detailed. Author

**N91-20213*#** Erie Community Coll., Buffalo, NY.
**SENSITIZATION OF STAINLESS STEEL** **c26**
James P. Nagy *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990

p 27-30 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 11F

The objective of this experiment is to determine the corrosion rates of 18-8 stainless steels that have been sensitized at various temperatures and to show the application of phase diagrams. The laboratory instructor will assign each student a temperature, ranging from 550 C to 1050 C, to which the sample will be heated. Further details of the experimental procedure are detailed. Author

**N91-20214*#** Wentworth Inst., Boston, MA.
**THE USE OF COMPUTERS IN A MATERIALS SCIENCE LABORATORY** **c61**
J. P. Neville *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 31-33 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 09B

The objective is to make available a method of easily recording the microstructure of a sample by means of a computer. The method requires a minimum investment and little or no instruction on the operation of a computer. An outline of the setup involving a black and white TV camera, a digitizer control box, a metallurgical microscope and a computer screen, printer, and keyboard is shown. Author

**N91-20215*#** Wentworth Inst., Boston, MA.
**CRYSTAL GROWING** **c76**
J. P. Neville *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 35-36 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 20L

One objective is to demonstrate the way crystals grow and how they affect the behavior of material. Another objective is to compare the growth of crystals in metals and nonmetals. The procedures, which involve a supersaturated solution of a salt that will separate into crystals on cooling and the pouring off of an eutectic solution to expose the crystals formed by a solid solution when an alloy of two metals forms a solid and eutectic solution on cooling, are described. Author

**N91-20216*#** Johns Hopkins Univ., Baltimore, MD.
**A DEMONSTRATION OF CHILL BLOCK MELT SPINNING OF METAL** **c26**
Robert B. Pond *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 37-39 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 11F

One of the most exciting adventures in materials in recent times has been the discovery of amorphous metals and the pursuit of methods of manufacturing various alloys into various shapes which are amorphous. Some of these alloys possess electrical properties which are extremely beneficial, whereas others offer different benefits such as corrosion resistence and no solidification shrinkage anomalies. There are a number of techniques for producing such amorphous shapes, but one of the earliest systems used is referred to as chill block melt spinning. The object of this demonstration is to show the simplicity of the process. The equipment and procedures are described. Author

**N91-20217*#** Drexel Univ., Philadelphia, PA. Dept. of Materials Engineering.
**FRACTURE OF BRITTLE SOLIDS** **c39**
R. D. Doherty and S. K. Nash *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 41-45 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 07C

Upon completion of this experiment, the student should be able to give an elementary account of brittle versus ductile failure, conduct a three-point bend test on a tensile testing machine, and statistically analyze experimental data that exhibit inherently wide scatter. The experimental procedure is described. Author

**N91-20218*#** National Bureau of Standards, Gaithersburg, MD. Inst. for Materials Science and Engineering.
**LOW CARBON STEEL: METALLURGICAL STRUCTURE VS. MECHANICAL PROPERTIES** **c26**
Robert D. Shull *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 47-50 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 11F

The objective is to provide a low cost, simple experiment for either demonstration purposes or as a laboratory experiment that will teach the student the importance of the thermal-mechanical history of a metallic alloy in determining that material's mechanical behavior. Hairpins are subjected to various treatments. The experimental equipment and procedures are discussed. Author

**N91-20219*#** National Bureau of Standards, Gaithersburg, MD. Inst. for Materials Science and Engineering.
**THE KELVIN WATER-DROP EXPERIMENT** **c25**
Robert D. Shull *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 51-53 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 07D

This experiment was originally designed and performed by Lord Kelvin (William Thomson) in the late 1800's to demonstrate the creation of an electric potential simply by means of dividing up a body of flowing water. The objective is to demonstrate the power of electrical forces in a material as common as water and to help teach the student that even simple, well understood phenomena sometimes present unexpected results that, at first thought, defeat explanation. The experimental equipment and procedure are explained. Author

**N91-20220*#** Buehler Ltd., Lake Bluff, IL.
**REVEALING THE MICROSTRUCTURE OF MATERIALS** **c25**
James A. Nelson *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 55-58 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 07D

The objectives are to demonstrate how the microstructure of materials may be revealed by abrasive polishing and chemical etching, and to illustrate how microstructural information is used to monitor manufacturing processes, provide in-depth inspection, and perform failure analysis. Microstructural analysis is the procedure used to reveal the internal microstructural details of a material or part by sectioning and polishing the cut surface so that it may be examined under a suitable microscope. A printed wiring board was selected as the test material because it contains both metals and nonmetals that have distinctive microstructures, and because this technique is used throughout the electronic industry as a key quality control tool. The three principle component materials in printed circuit boards are glass/epoxy laminates faced with copper foil; copper, deposited by both electroless and electrolytic plating; and tin/lead solder. Sample preparation, mounting, grinding, polishing, and examination and analysis are discussed. Author

**N91-20221*#** Pacific Northwest Lab., Richland, WA. Richland Schools.
**FIBERGLASS HAND LAMINATING PROCESS** **c24**
*In* NASA, Langley Research Center, National Educators' Workshop: Update 1988: Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 59-61 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 11D

In the study of polymers, it is important to know about thermoset and thermoplastic polymers. For the students to better understand

this experiment, they will need to know that epoxy resins, when reacted with a catalyst, form a thermoset polymer. The chemical reaction that takes place as the students mix these compounds together causes a special polymer bond known as crosslinking. It is because of this crosslinking that the tough, rigid properties of the thermoset polymer occur and are useful in this experiment. The student will be able to make a fiberglass composite and to apply and test the concept of combining two different materials to obtain a new material. The new material will exhibit new and better properties than the original materials. The student will understand the reason for combining materials to make a composite. Details of the experimental equipment and procedure are explained. Author

**N91-20222*#** Pacific Northwest Lab., Richland, WA. Richland Schools.
**MAKING AND TESTING SUPERCONDUCTORS c27**
*In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 63-68 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 11C

In these experiments the student will make a superconductor by employing the following techniques: chemical batching, mixing, grinding, heating, pressing, and tempering. The student will be able to verify the superconductivity of a material through testing by using two methods outlined in the procedure. Lastly, the student will be able to reason how superconductors can be used in our society. Experimental equipment and procedures are discussed. Author

**N91-20223*#** Colorado Superconductor, Inc., Fort Collins.
**HIGH TEMPERATURE SUPERCONDUCTORS: A TECHNOLOGICAL REVOLUTION c76**
*In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 71-83 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 20L

The objectives are to demonstrate the Meissner effect through magnetic levitation, to demonstrate one application of the Meissner effect, the low friction magnetic rotation bearing, and to demonstrate magnetic flux penetration and the Type II nature of ceramic superconductors via the stacking of the superconductor disks. Experimental equipment and procedures are described. Author

**N91-20224#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. Foreign Technology Div.
**SYNTHESIS OF ORGANIC COMPOUNDS (SELECTED ARTICLES)**
3 Oct. 1990 9 p Transl. into ENGLISH from Sintezy Organicheskikh Soyedineniy, Sbornik II (USSR), 1952 p 10-11 and 164-165
(AD-A229903; FTD-ID(RS)T-0992-90) Avail: NTIS HC/MF A02 CSCL 07/3

Synthesis is realized in essence as described for ethyl-orthotitanate. Into a three necked round bottomed flask with a capacity of 500 ml equipped with dropping funnel, reflux condenser and tube for the introduction of ammonia, are placed 102 g (1.75 g-mols) of thoroughly dried out allyl alcohol, which boils at 96 to 97 and 250 ml of absolute benzene. Cooler and dropping funnel are connected with the drying tubes. From dropping funnel during cooling of reaction flask by ice water gradually during 30 to 40 min. are added 60 g (0.32 g-mols) of titanium tetrachloride, after which reaction mixture is saturated by dry ammonia before the achievement of increase in weight not less than 25 g (1.46 g-mols). The fallen ammonium chloride is filtered out. GRA

# 24 COMPOSITE MATERIALS

Includes physical, chemical, and mechanical properties of laminates and other composite materials.
For ceramic materials see *27 Nonmetallic Materials.*

**N91-20225** Department of the Navy, Washington, DC.
**SUPPORT FOR THERMALLY EXPANDING CONICAL HEATSHIELD Patent**
Anthony D. Kelley, inventor (to Navy), James W. Finley, inventor (to Navy), Vernon F. Eachus, inventor (to Navy), Richard A. Lim, inventor (to Navy), and Miles K. Yano, inventor (to Navy) 27 Oct. 1987 6 p Filed 20 Jan. 1987
(AD-D014718; US-Patent-4,702,439; US-Patent-Appl-SN-005971; US-Patent-Class-244-158) Avail: US Patent and Trademark Office CSCL 11/4

The front end of a conical forward carbon-carbon heatshield is attached to carbon-carbon nose tip by a threaded connection. The nose tip provides rigid structural support for the small end of the heat shield at all conditions of thermal expansion. The joint between the aft end of the forward heatshield and the forward end of an aft carbon-phenolic heatshield includes a tolerance gap which is tapered to accommodate the vector movement of the carbon-carbon heatshield due to axial and circumferential thermal expansion. The gap is filled with a high temperature insulating washer of frangible material which is crushed by the axial expansion of the forward heatshield and evacuated by the slipstream. The forward heatshield is supported at the joint by a segmented ring of high density carbon wedges that will expand during flight and move with the heatshield along an expansion ramp to provide continuous support. Author

**N91-20226#** RNUR, Boulogne-Billancourt (France).
**EVALUATION OF FATIGUE BEHAVIOUR OF SMC COMPOSITES MATERIALS Abstract Only**
B. Confland and P. DeRoo 1991 1 p
Avail: NTIS HC/MF A01

Even if the use of Sheet Molding Compounds (SMCs) in structural automotive applications has increased over the last few years, their mechanical behavior is not yet well known. Due to its triphase structure, it contains a lot of stress concentrator sources which will influence the resistance and the mechanical behavior of the material. The fatigue behavior of SMC, tested under tensile and alternating plane bending fatigue is examined. Several damage parameters are followed during the fatigue tests: stiffness reduction, hysteresis loop measurement, and temperature increase. Preliminary investigations of the mechanical behavior were conducted and a testing methodology to be found in bending is tried, based on the previous observations. As SMC mechanical behavior is very different from the unidirectional reinforced composites, other experimental criteria have to be reached. Stages of damage were identified and related to microstructural mechanisms. During cycling the influence of frequency, the influence of maximum stress, and the accumulation of deformation were shown. Author

**N91-20227#** Agency of Industrial Science and Technology, Tsukuba (Japan). Industrial Products Research Inst.
**TENSION-TENSION AND DELAMINATION FATIGUE PROPERTIES OF CF/EPOXY LAMINATES**
Chohachiro Nagasawa, Hideki Sembokuya, Masaki Hojo, Kazutoshi Endo, Kiyoshi Kemmochi, and Hiroshi Maki (Takushoku Univ., Tate, Japan ) 1991 8 p Presented at a Seminar on Composite Materials: Processing, Use and Data Base, Paris, France, 13-14 Mar. 1990
Avail: NTIS HC/MF A02

The effects of the stress ratio on tension-tension fatigue behavior and growth of delamination fatigue cracks were investigated for Toray T300/3601, T800/3631, and T800/3601 laminates. Unidirectional laminates and (+-45/0/90)sub 2S laminates were used for tension-tension fatigue tests. The slopes of the S-N curves were small for all laminates. The influence of the stress ratio appeared to be smaller when the maximum stress was used for the S-N curve than when the stress range was

used. Tests of delamination fatigue crack growth of unidirectional laminates were carried out under mode I opening loading with double cantilever beam specimens. Exponents of the power functions were high. The analysis of the equivalent stress intensity range showed that the contribution of the maximum load was high. Similar analysis was carried out for the tension-tension fatigue tests. Mechanisms of tension-tension fatigue fracture were discussed on the bases of the stress ratio dependency and the fractographic observations. Author

**N91-20228*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**ISOTHERMAL FATIGUE BEHAVIOR OF A (90)(SUB 8) SiC/Ti-15-3 COMPOSITE AT 426 C**
John Gayda and Timothy P. Gabb Jan. 1991 21 p
(NASA-TM-103686; E-5904; NAS 1.15:103686) Avail: NTIS HC/MF A03 CSCL 11D

The transverse fatigue behavior of a unidirectional, SiC/Ti-15-3 composite (35 v/o SiC, (90)(sub 8)) was evaluated at 426 C. The fatigue behavior of the composite along the fiber direction (0)(sub 8) and of unreinforced Ti-15-3 alloy were also studied for comparison purposes. The (90)(sub 8) composite fatigue life was much shorter then (0)(sub 8) life. Further, (90)(sub 8) fatigue life was also found to be far lower than that of the unreinforced Ti-15-3 alloys. A simple one-dimensional model for (90)(sub 8) fatigue behavior indicated that the short life of the composite in this orientation resulted, in large part, from weak fiber-matrix bond strength. This conclusion was supported by fractographic evidence showing numerous initiation sites along the fiber-matrix interfaces. Author

**N91-20229#** Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Metallurgical Engineering and Materials Science.
**HIGH-TEMPERATURE METAL MATRIX COMPOSITES Final Report, 1 Oct. 1986 - 30 Sep. 1989**
A. W. Thompson 1 Jun. 1990 372 p
(Contract F49620-87-C-0017)
(AD-A230024; AFOSR-90-1168TR) Avail: NTIS HC/MF A16 CSCL 11/6

The Final Report, incorporating Year 3 of the University Research Initiative grant at Carnegie Mellon University on High-temperature Metal Matrix Structural Composites contains sections on processing, characterization, and mechanical properties. These are further divided into reports from individual tasks on powder blending and consolidation, composite performance, structure and composition of composite interfaces, fatigue crack growth, creep, and fracture behavior Detailed findings, together with listings of technical presentations and publications, are presented in the individual reports from the six tasks conducted under this Grant. GRA

**N91-20230#** David Taylor Research Center, Bethesda, MD. Dept. of Ship Materials Engineering.
**A COMPARISON OF THE COMPRESSION RESPONSE OF THICK (6.35 mm) AND THIN (1.60 mm) DRY AND MOISTURE SATURATED AS4/3501-6 LAMINATES Final Report, Jun. 1989 - Oct. 1990**
Karin Gripple Oct. 1990 122 p
(AD-A230056; DTRC-SME-90/74) Avail: NTIS HC/MF A06 CSCL 11/4

The compression response of thick (6.35 mm) and thin (1.60 mm) (O2/90)sub(s) AS4/3501-6 laminates was compared for material in the dry and moisture saturated conditions. The thick specimens failed at 1055 MPa dry and 740 MPa wet. Comparable strengths for the thin specimens were 1090 and 957 MPa. There was no statistical difference in strength for the dry material of either thickness. The thick specimens absorbed significantly more water than the thin specimens, and consequently, showed a greater loss in compression strength. The elastic modulus was not affected by moisture in the thick or thin specimens. The gross failure mode of the dry and wet specimens of either thickness was very similar with slightly more delamination occurring in the wet specimens. The thick specimens typically exhibited angular cracks of 27 to 30 degrees partially across the specimen thickness. This was not observed in the thin specimens. Finite element techniques were used to determine shear stresses in the matrix for a fiber-matrix composite plate with an initial imperfection, and loaded in compression. These matrix shear stresses were used in a compression failure theory which showed reasonable agreement with experimental results. It appears that the detrimental influence of the moisture is the degradation of the matrix shear modulus at high compressive stresses with high moisture concentrations. GRA

**N91-20231#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**INVESTIGATION OF FATIGUE DAMAGE MECHANISMS IN A METAL MATRIX COMPOSITE UNDER ELEVATED TEMPERATURE M.S. Thesis**
Barry D. Portner Dec. 1990 105 p
(AD-A230388; AFIT/GAE/ENY/90D-20) Avail: NTIS HC/MF A06 CSCL 20/11

This study investigated the fatigue damage initiation and progression in SCS-6/Ti-15-3 under an environment of fatigue loading at isothermal temperature. This program included two parts. First, an 808 Ultimate Tensile Strength system was set up to accommodate testing at two frequencies of 2.0 and 0.0208 cps at a constant temperature of 427 C. Second, at intervals during the load cycle process, the test specimens were characterized by establishing damage parameters based on changing modulus of elasticity, average strain, strain range, and ultimate tensile strength. Damage progression was documented in the form of failure of the fiber-matrix interface, matrix cracking, fiber breaking, and debonding of the fibers. Crack initiation locations and growth patterns were peculiar to specific test conditions of frequency and stress level. Also, analysis of the fatigued specimens and test data revealed matrix failure mechanisms ranging from ductile failure to cleavage fracture. The results of this study clearly show that temperature, frequency as well as stress levels are important design considerations for this composite in fatigue loading applications. GRA

**N91-20232#** Greene (Eric) Associates, Inc., Annapolis, MD.
**USE OF FIBER REINFORCED PLASTICS IN THE MARINE INDUSTRY**
Eric Greene 6 Sep. 1990 287 p
(Contract DTCG23-89-C-20015)
(AD-A230414; PB91-129270; SSC-360; SR-1328) Avail: NTIS HC/MF A13 CSCL 11/4

The use of fiberglass Reinforced Plastic (FRP) has increased recently in marine structures with a minimum of engineering analysis and design evolution. Although fiberglass has been used for many years in small recreational and high-performance boats, a range of new composite materials are now being utilized for various applications. The objective of this document is to examine the use of FRP and other composite materials in marine construction; determine important considerations in past design; review developments in related industries; predict areas for future marine applications; and recommend future research needs. GRA

**N91-20233#** Tennessee Univ., Knoxville. Dept. of Engineering Science and Mechanics.
**AN ECCENTRIC SHEAR-LAG MODEL AND IMPLICATIONS ON THE STRENGTH OF FIBROUS COMPOSITES Technical Report, 1 Jan. - 30 Sep. 1990**
Y. Weitsman 19 Nov. 1990 29 p
(Contract N00014-90-J-1556)
(AD-A229733; SDM90-1.0-MECH) Avail: NTIS HC/MF A03 CSCL 11/4

The stress field in the vicinity of a broken fiber-reinforced composite is analyzed by means of a shear-lag model. The broken filament is positioned eccentrically relative to its neighboring fibers to simulate the commonplace non-uniformity of fiber spacing within the transverse plane. It is shown that a fiber break gives rise to severe bending, in addition to tension, in the neighboring fiber - with a substantial overstress focused on the nearest unbroken

filament. The complex nature of the stress field, which is caused by the failure of a fiber within the composite casts doubt on the applicability of failure statistics derived from tensile failure data of single fibers to predict the strength of composites. GRA

**N91-20234#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**FAILURE MECHANISMS IN A QUASI-ISOTROPIC CERAMIC COMPOSITE LAMINATE UNDER TENSILE FATIGUE LOADING M.S. Thesis**
Gregory D. Tracy Dec. 1990 87 p
(AD-A230470; AFIT/GAE/ENY/90D-30) Avail: NTIS HC/MF A05 CSCL 13/4

A study was conducted to experimentally investigate the tensile fatigue damage mechanisms in a quasi-isotropic ceramic matrix composite (Corning's Nicalon/CASIII). The goals of this study were to (1) develop a grip fixture for a servo-hydraulic test machine and (2) conduct a series of tests with (0/-45/90)s specimens subjected to tensile fatigue loading to study their fatigue damage growth mechanisms. Results showed that when the material was subjected to stresses below 90 MPa, it lasted over one million cycles but when stressed at or above 90 MPa, it failed in less than 1000 cycles. GRA

**N91-20235#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**MICROMECHANICAL MODELING OF THE FIBER/MATRIX INTERFACE REGION IN A METAL MATRIX COMPOSITE M.S. Thesis**
David D. Robertson Dec. 1990 145 p
(AD-A230529; AFIT/GAE/ENY/90D-22) Avail: NTIS HC/MF A07 CSCL 11/4

In order to develop reasonable analytical models and to better understand how the integrity of the fiber/matrix interface in high temperature titanium based metal matrix composites effects the overall transverse normal characteristics, a parametric study of various fiber/matrix interface conditions was performed. Analysis methods included both a simplified one-dimensional mathematical model and a finite element analysis using MSC/NASTRAN. First, both strong and weak interfacial bonds were examined. Subsequently, to provide for partial bonding, a model that used an elastic-plastic interphases zone between the fiber and matrix was examined. GRA

**N91-20236#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**INVESTIGATION OF DAMAGE MECHANISMS IN A CROSS-PLY METAL MATRIX COMPOSITE UNDER THERMO-MECHANICAL LOADING M.S. Thesis**
Joel J. Schubbe Dec. 1990 163 p
(AD-A230544; AFIT/GAE/ENY/90D-26) Avail: NTIS HC/MF A08 CSCL 11/4

Metal matrix composites (MMC's) are rapidly becoming strong candidates for high temperature and high stiffness structural applications such as the advanced tactical fighter (ATF). This study systematically investigated the failure modes and associated damage in a cross-ply, (0/90)2s SCS6/Ti-15-3 metal matrix composite under in-phase and out-of-phase thermomechanic fatigue. Initiation and progression of fatigue damage were recorded and correlated to changes in Young's Modulus of the composite material. Experimental results show an internal stabilization of reaction zone size but degradation and separation from constituent materials under extended cyclic thermal loading. Critical to damage were transverse cracks initiating in the 90 degree plies, growing and coalescing from fiber/matrix interfaces internal to the specimen, progressing outward through the 0 degree plies before failure. Maximum mechanical strain at failure was determined to be approximately 0.0075 mm/mm. A correlation was made relating maximum matrix stress to failure life, resulting in a fatigue threshold limit of 280 MPa. An attempt was made to correlate the degradation in Young's Modulus (damage = 1-E/Eo) with the applied life cycles from different TMF tests. GRA

**N91-20237#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**FINITE ELEMENT INVESTIGATION INTO THE DYNAMIC INSTABILITY CHARACTERISTICS OF LAMINATED COMPOSITE PANELS M.S. Thesis**
Walter W. Taylor, Jr. Dec. 1990 96 p
(AD-A230610; AFIT/GAE/ENY/90D-28) Avail: NTIS HC/MF A05 CSCL 11/4

Dynamic instability of a laminated composite panel subjected to a transverse load is studied. Up to cubic variations in the thickness coordinate are included in the inplane displacement field, and only the constant component is kept in the transverse displacement. The transverse shear strains retain only linear displacement terms and vary parabolically through the thickness. The complete quadratic displacement functions are included in the inplane strains. A 36 degree of freedom shell element is used to obtain numerical results. The static snap through load vs. displacement curve, as well as the critical collapse load, is examined by invoking the Riks technique along with the Newton-Raphson iteration scheme. The beta-m time marching integration method is employed to evaluate a dynamic response. Two step loads, with the step magnitude slightly below and above the critical collapse load, are introduced in the dynamic analysis. The response resulting from the dynamic analysis matches the displacement on the static load vs. displacement curve. GRA

**N91-20238#** European Space Agency, Paris (France).
**THEORETICAL AND EXPERIMENTAL ANALYSIS OF THE EFFECT OF MICROSTRUCTURAL PARAMETERS OF THE PROPERTIES OF BRITTLE-MATRIX COMPOSITES**
Patrick Peres (Office National d'Etudes et de Recherches Aerospatiales, Paris, France ) Jan. 1991 343 p Transl. into ENGLISH of Analyse Theorique et Experimentale du Role des Parametres de Microstructure sur le Comportement des Composites a Matrice Fragile (Paris, France, ONERA), 1988 Original language document was announced as N89-29494
(ESA-TT-1167; ONERA-NT-1988-4; ETN-91-98965) Avail: NTIS HC A15/MF A01

The behavior of ceramic matrix composites reinforced with long continuous ceramic fibers, under simple mechanic stresses at room temperature, was studied. In a micromechanical approach, the emphasis was placed on checking the parameters for the manufacture of unidirectional SiC/LAS (the ternary system of lithium, aluminum and silicon oxides are the foundation for the LAS family) glass composites and their physiochemical characteristics. An experimental methodology for the micromechanical characterization of ceramic composites was developed, incorporating the development of two experiments which consist of mechanical analysis of the fiber matrix interface by the instrumented microindentation technique and tensile loading under optical microscope, making it possible to identify the fracture phenomena arising under load. Interpretation of the cracking phenomena and the investigation of the sensitivity of the microstructure parameters are based on numerical simulations which incorporate mainly the concept of interface slip and fracture statistics. These simulations relate to models which can provide a description of multiple cracking in monofilament composites and propagation of a matrix crack in a fiber reiforced plate. ESA

**N91-20239#** European Space Agency, Paris (France).
**ELECTROCHEMICAL TREATMENTS IN AN ORGANIC MEDIUM OF CARBON FIBRES WITH LAMINATED SUBSTRATE. EFFECTS OF THESE TREATMENTS ON THE MECHANICAL PROPERTIES OF CARBON-EPOXY COMPOSITES**
Blandine Barbier (Office National d'Etudes et de Recherches Aerospatiales, Paris, France ) Nov. 1990 242 p Transl. into ENGLISH of Traitements Electrochimiques en Milieu Organique defibres de Carbone: Substrait Amine. Effects de ces Traitements sur des Proprietes Mecaniques de Composites Carbone-Epoxy (Paris, France, ONERA), 1989
(ESA-TT-1193; ONERA-NT-1989-6; ETN-91-98968) Avail: NTIS HC/MF A11

Work directed towards improving the toughness of carbon epoxy

composites by carrying out laminated treatments is presented. The great variety of laminated molecules capable of being grafted onto the surface of the fiber is exploited. The combination of high tensile strength XAU Courtaulds fibers and Narmco 5208 resin was used and enabled the effectiveness of the subsequent surface treatments to be assessed. The operating conditions for the described electrochemical treatments were determined from fragments of yarn immersed in a voltametric cell. X-ray photoelectron and secondary ion mass spectroscopy surface analyses were used to specify the nature of the grafted groups and their distribution. Pull out tests were used to characterize the fiber matrix adhesion. The grafting mechanism of ethylenediamine was investigated. Mechanical properties of fabricated composites having fibers with different laminated molecules were compared by using measurements of the mode 1 crack propagation energy and of interlaminar shear strength. ESA

**N91-20240** National Physical Lab., Teddington (England). Div. of Materials Applications.
**STANDARDS FOR POLYMER MATRIX COMPOSITES. PART 1: ASSESSMENT OF CRAG TEST METHODS DATA**
Graham D. Sims Sep. 1990 39 p
(NPL-DMM(A)-6-Pt-1; ISSN-0959-2423; ETN-91-99018)
Copyright Avail: National Physical Lab., Teddington, Middlesex, TW11 0LW, England

The test methods recommended in the Composites Research Advisory Group (CRAG) working party report for polymeric matrix composites are reviewed and grouped under four types. For the basic mechanical property tests in Groups A and B data was obtained from CRAG members and other sources. Much of the data in company files was obtained by methods no longer recommended or not in full agreement with the CRAG methods. The data was assessed against the requirement to validate these methods in terms of their repeatibility and reproducibility (i.e., precision). The coefficient of variation for modulus measurements for all test modes was mainly between 0.6 and 6.0 percent, with a peak value of 8.7 percent for flexure. The equivalent figures for strength measurements are 0.7 to 10 percent, with a peak at 20 percent. The variability is higher for measurements between sites but few comparisons were available. The data suggest that the methods were generally found to be reliable and to give low scatter. While the repeatibility is demonstrated to be accepted for individual sites, the site to site reproducibility was not demonstrated due, in part, to a lack of available data. Any round robin tests undertaken should be aimed eventually at European, international, or a joint standards implementation level rather than at British level. ESA

**N91-20241*#** Pennsylvania State Univ., University Park. Center for Advanced Materials.
**THE HIGH TEMPERATURE CREEP BEHAVIOR OF OXIDES AND OXIDE FIBERS**
Linda E. Jones and Richard E. Tressler Jan. 1991 117 p
(Grant NAGw-1381)
(NASA-CR-187060; CAM-9009; NAS 1.26:187060) Avail: NTIS HC/MF A06 CSCL 11D

A thorough review of the literature was conducted on the high-temperature creep behavior of single and polycrystalline oxides which potentially could serve as fiber reinforcements in ceramics or metal matrix applications. Sapphire when oriented with the basal plane perpendicular to the fiber axis (c-axis oriented) is highly creep resistant at temperatures in excess of 1600 C and applied loads of 100 MPa and higher. Pyramidal slip is preferentially activated in sapphire under these conditions and steady-state creep rates in the range of 10(exp -7) to 10 (exp -8)/s were reported. Data on the creep resistance of polycrystalline beryllia suggest that C-axiz oriented single crystal beryllia may be a viable candidate as a fiber reinforcement material; however, the issure of fabricability and moisture sensitivity must be addressed for this material. Yttrium aluminum garnet (YAG) also appears to be a fiber candidate material having a high resistance to creep which is due to it's complex crystal structure and high Peierl resistance. The high creep resistance of garnet suggests that there may be other complex ternary oxides such as single crystal mullite which may also be candidate materials for fiber reinforcements. Finally, CVD and single crystal SiC, although not oxides, do possess a high resistance to creep in the temperature range between 1550 and 1850 C and under stresses of 110 to 220 MPa. From a review of the literature, it appears that for high creep resistant applications sapphire, silicon carbide, yttrium aluminum garnet, mullite, and beryllia are desirable candidate materials which require further investigation. Author

**N91-20110*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**ADVANCED HIGH TEMPERATURE ENGINE MATERIALS TECHNOLOGY PROGRAM**
Hugh R. Gray *In its* Aeropropulsion 1991 Mar. 1991 28 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 11D

**N91-20111*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**COMPUTATIONAL MATERIALS SCIENCE. AN EXAMPLE: NUMERICAL MODELING OF CHEMICAL VAPOR DEPOSITION PROCESSING OF ADVANCED FIBERS**
Arnon Chait, Suleyman Gokoglu, Maria Kuczmarski, Pang Tsui, Lisa Veitch, David Thompson, and Ronald Gaug (Akron Univ., OH.) *In its* Aeropropulsion 1991 Mar. 1991 16 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 11D

**N91-20221*#** Pacific Northwest Lab., Richland, WA. Richland Schools.
**FIBERGLASS HAND LAMINATING PROCESS**
*In* NASA, Langley Research Center, National Educators' Workshop: Update 1988: Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 59-61 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 11D

# 25 INORGANIC AND PHYSICAL CHEMISTRY

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

For related information see also *77 Thermodynamics and Statistical Physics.*.

**N91-20242** Department of the Navy, Washington, DC.
**COMBUSTION EFFICIENCY ANALYZER, ACOUSTIC Patent**
Herbert A. Palmer, inventor (to Navy) 25 Sep. 1990 5 p Filed 3 Jul. 1989
(AD-D014693; US-Patent-4,959,638; US-Patent-Appl-SN-374710)
Avail: US Patent and Trademark Office CSCL 21/2

A device for monitoring combustion efficiency of a burner with a burner flame has an acoustic sensor probe positioned within the burner, flame signature generating circuitry responsive to the acoustic probe, and means for correlating flame signatures with known optimum efficiency characteristics to yield an indication of relative combustion efficiency. The device also has output means for display of the relative combustion efficiency. This invention relates to an acoustic combustion efficiency analyzer. Combustion equipment is sensitive to changes in atmospheric conditions. Insufficient air results in incomplete combustion of fuel; excess air quenches flame temperature and reduces the efficiency of heat transfer. Also, combustion equipment, particularly of the oil fueled variety, is readily thrown out of adjustment by such phenomena as progressive fouling. Constant and precise burner flame adjustments are required in order to maximize burner efficiency in the presence of atmospheric changes and progressive fouling. GRA

**N91-20243** Tel-Aviv Univ. (Israel). Dept. of Geophysics and Planetary Sciences.
**A METHOD FOR MEASURING THE MASS OF SULFUR IN SINGLE NON-HOMOGENEOUS AEROSOLS BY X-RAY ANALYSIS, USING THE SCANNING ELECTRON MICROSCOPE M.S. Thesis**
Doron Pardess Aug. 1988 82 p In HEBREW; ENGLISH summary
(ITN-91-85096) Copyright Avail: Tel-Aviv Univ., Exact Sciences Library, Ramat Aviv 69978, Israel

In the absence of a satisfactory method for measuring the mass of sulfur or sulfate in wet or non-homogeneous aerosols involving large droplets, it was necessary to devise a method to measure it for single particles. A reliable, precise, easily performed method was required, to measure sulfur masses down to 10(exp -14) gram, in single particles measuring from 0.4 micron to several microns. The method developed is based on x-ray analysis, using a scanning electron microscope; it assumes that the characteristic x-ray emission produced by excitation depends on the number of sulfur atoms present, and the electron beam voltage and current. For small particles, no corrections for atomic number, absorption and fluorescence were necessary. The 6920-eV cobalt x-ray line was used as a normalizing standard; acceleration voltages of 10, 15 and 25 kV were used, and currents not exceeding 10(exp -9) Ampere. Sulfur calibration curves were obtained by depositing single, spherical, dry particles of ammonium sulfate, from a Berglund-Liu Monodiperse Aerosol Generator, onto carbon coated electron microscope grids, and calculating the sulfur content from the electron microscope-measured particle dimensions. Checking the calibration curves against curves obtained for sodium sulfate particles yielded a maximum relative error of 15 percent. The method developed was found to satisfy the specified conditions, and to be suitable for rapid analysis of the sulfur content of atmospheric pollution. ISA

**N91-20244#** Geo-Centers, Inc., Newton, MA.
**MECHANISMS AND KINETICS OF CATALYTIC REACTIONS Final Report, Dec. 1988 - May 1990**
Stephanie M. Garlick Aug. 1990 113 p
(Contract DAAA15-87-D-0007)
(AD-A229912; GC-TR-90-1728-008; CRDEC-CR-084) Avail: NTIS HC/MF A06 CSCL 07/4

Second order rate constants, KIBA were determined for unsubstituted and 4-alkyl substituted o-iodosobenzoate catalyzed hydrolysis of the simulant p-nitrophenyl-diphenyl phosphate in microemulsions containing surfactants: cetyltrimethyl-ammonium bromide/chloride, or cetylpyridinium chloride; cosurfactants: 1-alkyl-2-pyrrolidinones, N,N-dialkylformamides, tetraalkyl-ammonium chloride/bromide; oils: hexadecane, toluene, 4-tert-butyltoluene, and perchloroethylene. Additional cosurfactants containing N-C=O functionality, double-tailed surfactants, and aromatic N-alkyl oils were also employed. Phase diagrams and maps were constructed. The kinetics were optimized by varying component concentrations. GRA

**N91-20245#** Cornell Univ., Ithaca, NY.
**VOLTAMMETRIC MEASUREMENT OF BIMOLECULAR ELECTRON-TRANSFER RATES IN LOW IONIC STRENGTH SOLUTIONS**
John D. Norton, Wendy E. Benson, Henry S. White, Bradford D. Pendley, and Hector D. Abruna Nov. 1990 21 p Prepared in cooperation with Minnesota Univ., Minneapolis
(Contract N00014-84-K-0656)
(AD-A229913) Avail: NTIS HC/MF A03 CSCL 09/1

Electrochemical investigations of homogenous chemical reactions that are coupled to an initial electron transfer step are frequently based on methods in which the mass transfer coefficient of a reactant or intermediate is experimentally varied relative to the inherent rate of the chemical reaction. Common methods employed in studying coupled chemical reactions include the rotating disk electrode (RDE), rotating ring-disk electrode (RRDE), and cyclic voltammetry. In the RDE and RRDE experiments, the rate of mass transfer is proportional to the square root of the electrode rotation rate so that the mass transfer rate may be adjusted to a value comparable to the rate of the chemical reaction. The dependence of the limiting current in this experimental regime may be analyzed, using appropriate kinetic equations, to determine the rate constant of a chemical reaction. GRA

**N91-20246#** Minnesota Univ., Minneapolis. Dept. of Chemical Engineering and Materials Science.
**VOLTAMMETRIC MEASUREMENT OF BIOMOLECULAR ELECTRON-TRANSFER RATES IN LOW IONIC STRENGTH SOLUTIONS Technical Report, 1 Jan. - 31 Oct. 1990**
John D. Norton, Wendy E. Benson, Henry S. White, Bradford D. Pendley, and Hector D. Abruna 16 Nov. 1990 24 p
(Contract N00014-87-K-0494)
(AD-A229918; TR-13-ONR) Avail: NTIS HC/MF A03 CSCL 12/2

Numerical analysis of the sequential electron transfer mechanism, A yields A(+) + e(-), A(+) yields A2(+) + e(-) demonstrates that the rate at which A can be directly oxidized to A2(+) is inhibited in low ionic strength solutions by the coupled diffusion-migration of chemically generated A(+). The latter species, A(+) is produced within the depletion layer by the homogenous reaction, A + A2(+), and is electrostatically repelled from electrode surface, thereby reducing the flux of A at the electrode surface. Steady state voltammetric currents corresponding to two examples of this reaction mechanism, the oxidation of tetrathia fulvalene (TTF) and the reduction of tetracyano quinodimethane (TCNQ), were measured at platinum microdisk electrodes over a wide range of electrolyte concentrations (0 to 0.1M). GRA

**N91-20247#** Dayton Univ., OH. Research Inst.
**MECHANISMS OF CHEMICAL VAPOR DEPOSITION ON CARBON FIBERS Interim Report, May 1988 - Aug. 1989**
Ismail M. Ismail Oct. 1990 43 p
(Contract F04611-88-C-0020)
(AD-A230035; UDR-TR-89-79; AL-TR-89-079) Avail: NTIS HC/MF A03 CSCL 11/2

Deposition of pyrolytic carbon on the surface of carbon substrates, including carbon fibers, was studied at 1000 to 1100 C using two different systems, a static reactor operating at subambient pressures and a flow reactor operating at atmospheric pressure. The experimental parameters that affect the deposition rates and mechanism are substrate temperature, type of reactor used, total and partial pressure of methane in the static reactor, partial pressure of methane in the flow reactor, flow rate of hydrocarbon above substrate, presence of hydrogen in the deposition medium, and the type of substrate, as well as its surface area. The two main differences between the deposition under flow and static conditions are rates of deposition and characteristics of deposits. While the rate under flow conditions is considerably higher than under static conditions, the deposits in the flow reactor are intact and less porous than those prepared in the static reactor. This is attributed essentially to the presence of hydrogen in the static reactor which lowers the rates of deposition, prevents the growth of intermediate species to large planar molecules, and attacks the carbon deposits. GRA

**N91-20248#** Ballistic Research Labs., Aberdeen Proving Ground, MD.
**Ar(+) LASER EXCITED FLUORESCENCE OF DIATOMIC COMBUSTION RADICALS IN A FLAME Final Report, Nov. 1989 - Aug. 1990**
John A. Vanderhoff and M. W. Teague Nov. 1990 23 p
(AD-A230155; BRL-TR-3173) Avail: NTIS HC/MF A03 CSCL 20/5

The ultraviolet prism selected lines of an Argon + laser have been investigated for excitation of diatomic combustion radicals in a flame. Fluorescence excitation has been observed for CN, NH, and OH using the laser lines 379.5, 335.6, and 302.4 nm, respectively. GRA

**N91-20249#** Stanford Univ., CA.
**SURFACE-CATALYZED CHEMILUMINESCENCE Final Report, 15 Apr. - 14 Oct. 1990**
Richard N. Zare 10 Dec. 1990 5 p
(Grant AF-AFOSR-0254-90; AF Proj. 1692)
(AD-A230176; AFOSR-90-1200TR) Avail: NTIS HC/MF A01 CSCL 09/3

Intense red emission peaking at 703 mm was observed when a heated metal wire was placed downstream of an O2 generator used in the chemical oxygen iodine laser (COIL) system. The O2 is produced by bubbling Cl2 through an alkaline solution of H2O2. Evidence was found that this strong red emission requires the presence of both O2 and Cl2 in contact with a heated metal surface. Several metals were used. The red emission spectrum is independent of the metal and the intensity is strongest for copper. An attempt was made to observe laser action but no gain was detected. The identity of the species responsible for the strong red emission was not established. GRA

**N91-20250#** IBM Research Lab., San Jose, CA.
**IN SITU FTIR STUDY OF THE ADSORPTION GEOMETRY OF BISULFATE IONS ON A PLATINUM ELECTRODE**
Mahesh G. Samant, Keiji Kunimatsu, Hajime Seki, and Michael R. Philpott 1990 21 p
(Contract N00014-82-C-0583)
(AD-A229793; TR-23) Avail: NTIS HC/MF A03 CSCL 07/4

It is shown that a better understanding of the geometry of adsorbed bisulfate species on the surface is gained by simultaneously monitoring more than one vibrational mode of the molecule. It is proposed that in the double layer region the bisulfate ions are adsorbed via an oxygen atom of its SO3 unit with the Pt-O-S linkage along the surface normal. In the oxide region the bisulfate ions are adsorbed on the oxygen covered surface of the platinum electrode via the hydrogen atom by hydrogen bonding with the hydrogen bond showing a significant tilt (approx. 60 deg). GRA

**N91-20251#** Oxford Univ. (England).
**NONLINEAR WAVE AND DIFFUSION EQUATIONS Final Report**
J. B. McLeod and J. R. Ockendon Aug. 1990 9 p
(Contract DAJA45-86-C-0040)
(AD-A229795) Avail: NTIS HC/MF A02 CSCL 20/4

This research has consisted of a number of investigations into nonlinear wave and diffusion equations. These make their appearance in many mathematical modelling problems, and applications were studied in the field of fluid dynamics, heat and mass transfer, and superconductivity. The problems were tackled using the expertise available both through permanent staff members and through a visitor program, and equal emphasis was laid on analytical techniques, numerical techniques, and modelling. Some topics of discussion are as follows: (1) Lens and Antenna design; (2) Blow up and Quenching for Nonlinear Diffusion Equations; (3) Wedge Entry; (4) Asymptotics Beyond All Orders; (5) Higher-order Diffusion; (6) Macroscopic Models for Solidification; (7) Mathematical Models for Fiber Tapering; (8) Semiconductor Fabrication; (9) Superconductivity Modelling; (10) Hypersonic Flow; and (11) Combustion in Porous Media. GRA

**N91-20252#** New Orleans Univ., LA. Dept. of Chemistry.
**COMPUTATIONAL STUDIES OF POLYNITROAROMATIC MOLECULES AND THE DEVELOPMENT OF SENSITIVITY RELATIONSHIPS, PART 2 Final Report, Jun. 1987 - Jun. 1990**
Peter Politzer Oct. 1990 273 p
(Contract F08635-87-C-0090)
(AD-A229807; AFATL-TR-90-66-Pt-2) Avail: NTIS HC/MF A12 CSCL 07/3

A computational study of 48 nitroaromatic molecules was carried out with the objective of developing an understanding of how chemical structural features are related to the shock/impact sensitivities of these molecules. An ab initio self-consistent field molecular orbital procedure was used to compute a variety of properties, including atomic charges, electrostatic potentials and ionization potentials. From the results of the computational analyses, it is suggested that the observed high sensitivities of hydroxytrinitroaromatics toward shock and impact may be due to the formation of small but significant quantities of unstable nitronic acid tautomers. When the hydroxynitroaromatics are excluded, the sensitivity is shown to be related to the C-NO2 linkage with the greatest instability, as measured by the electrostatic potential at the midpoint of the C-NO2 bond; this is an extension of a relationship discovered earlier. GRA

**N91-20253#** General Electric Co., Schenectady, NY.
**FEEDBACK CONTROL OF COMBUSTION INSTABILITIES: A CASE STUDY IN ACTIVE ADAPTIVE CONTROL OF COMPLEX PHYSICAL SYSTEMS Annual Letter Report for FY90, 1 Oct. 1989 - 30 Sep. 1990**
George Goodman 30 Sep. 1990 9 p
(Contract N00014-89-C-0052)
(AD-A229812) Avail: NTIS HC/MF A02 CSCL 21/4

The following issues are addressed: Previous studies on small (1 kW), premixed, gas fueled combustors have demonstrated suppression of longitudinal mode combustion instability using pressure (or heat release) feedback and loudspeaker modulation. Can the same results be achieved on a larger scale (200 kW), liquid fueled combustor using a more practical actuation means. Owing to the high order and nonlinear nature of the processes involved, it is expected that a single, linear, time invariant (LTI) controller would be capable of stabilizing the combustor over only a small range of airflows and equivalence ratios. To provide a research test bed, 3 by 3 in, premixed gas combustor will be modified to accept liquid fuel admitted through a high bandwidth, Moog servo valve. Fuel flow modulation will be tried first as a means of actuation. If necessary, a fuel pressure feedback loop will be closed around the valve to extend its bandwidth even further. A screech map will then be obtained by measuring the combustor pressure power spectrum at several combinations of airflow rates and equivalence rations. Based on these measurements, and on the experience with the 1 kW combustor, a screeching operating point will be selected at which to begin the control system design. GRA

**N91-20254#** Naval Ocean Systems Center, San Diego, CA.
**LIQUID METAL FUEL COMBUSTION MECHANICS**
Tirumalesa Duvvuri Dec. 1990 10 p Previously announced in IAA as A90-42118
(AD-A230648) Avail: NTIS HC/MF A02 CSCL 21/4

The modeling of the droplet formation at the gas/liquid boundary interface of a gaseous jet injected into a liquid metal bath and the turbulent mixing of the resultant two-phase (gas/liquid droplets) mixture is presented as a preliminary to the analysis of the liquid metal fuel combustion problem. The model is used to predict velocity and liquid droplet fraction distributions across the mixing zone and along the centerline of the jet. These results show that the distribution of the liquid fuel droplets peaks away from the region of maximum oxidizer concentrations. GRA

**N91-20255#** California Univ., San Diego, La Jolla. Dept. of Applied Mechanics and Engineering Sciences.
**MECHANISMS OF COMBUSTION OF HYDROCARBON/ALCOHOL FUEL BLENDS Final Technical Report, 15 Oct. 1985 - 28 Feb. 1981**
Kalyanasundaram Seshadri 1 Nov. 1990 90 p
(Contract DAAL03-86-K-0001)
(AD-A230709; ARO-22612.11-EG) Avail: NTIS HC/MF A05 CSCL 21/4

The principal objective of this research is to obtain an improved understanding of the structure of laminar flames burning hydrocarbon fuels, alcohol fuels, and blends of hydrocarbon and alcohol fuels. This works attempts to support the U.S. Army's research and development programs in alternative fuels. Since, there is convincing evidence that turbulent reacting flows can be modelled as statistical ensemble of laminar flamelets, an experimental, numerical and analytical study was undertaken to

clarify the structure and mechanisms of extinction of laminar diffusion flamelets, laminar premixed flamelets, and laminar partially premixed flamelets. GRA

**N91-20256** National Physical Lab., Teddington (England). Div. of Materials Applications.
**CRACK-TIP ELECTROCHEMISTRY**
Alan Turnbull Jul. 1990 34 p
(NPL-DMM(A)-9; ISSN-0959-2423; ETN-91-99019) Copyright
Avail: National Physical Lab. Teddington, Middlesex, TW11 0LW, England

A description of the mathematical methods and experimental techniques used in characterizing the local environment and potential at the tip of a crack is given. The factors determining the local crack tip conditions are discussed and the application of models and experiments to particular metal environment systems is described. The present status of knowledge is evaluated in the context of predictive modeling of crack growth rates. ESA

**N91-20257** National Physical Lab., Teddington (England). Div. of Materials Applications.
**VAMAS STUDY OF INTENSITY STABILITY OF CYLINDRICAL MIRROR ANALYZER BASED AUGER ELECTRON SPECTROMETERS**
M. P. Seah Dec. 1990 23 p
(NPL-DMM(A)-16; ISSN-0959-2423; ETN-91-99023) Copyright
Avail: National Physical Lab., Teddington, Middlesex, TW11 0LW, England

The intensity energy calibration of Auger electron spectrometers was defined in an earlier study. Here, the changes in calibration that occur after further years of use are determined. Five respondees using cylindrical mirror analyzers from the earlier interlaboratory study remeasured spectra for the Cu, Ag and Au reference materials SCAA 87 under standard conditions. The results show that two instruments perform as before with no effective change in calibration, two have 10 percent lower intensities at energies below 100 eV and one has 100 percent higher intensities at low energy when the spectra are all normalized at 100 eV. These changes arise from ageing of the Channel Electron Multiplier (CEM) detectors and the effects of stray magnetic fields. Calculations are provided to show the improvements in stability achieved by biasing the front of the CEM by +250 V. ESA

**N91-20258#** Los Alamos National Lab., NM.
**PULSED PHOTOTHERMAL SPECTROSCOPY APPLIED TO LANTHANIDE AND ACTINIDE SPECIATION**
J. M. Berg, D. E. Morris, D. L. Clark, C. D. Tait, W. H. Woodruff, and W. G. VenDerSluys (Montana Univ., Missoula.) 1991 8 p Presented at the OE/LASE '91: 4th Society of Photo-Optical Instrumentation Engineers (SPIE) International Symposium, Los Angeles, CA, 20-25 Jan. 1991
(Contract W-7405-eng-36)
(DE91-007391; LA-UR-91-147; CONF-910123-1) Avail: NTIS HC/MF A02

Several key elements important for the application of laser-based photothermal spectroscopies to the study of the complexation chemistry of lanthanides and actinides in solution have been demonstrated. The sensitivity of f-f electronic transition energies and band intensities to subtle changes in complexation was illustrated through comparison of visible and near infra-red absorption spectra of well-characterized U(IV) dimers with alkoxide ligands. Significant improvements in spectroscopic band resolution and energy measurement precision for solution species were shown to be achievable through work in frozen glasses at 77 K using a very simple cryogenic apparatus. A pulsed-laser photothermal spectroscopy apparatus was constructed and shown to be sensitive to optical density changes of 10(exp -5) in an aqueous Nd(3+) solution. In addition, the capability of obtaining photothermal lensing spectra of dilute actinide solutions in frozen glasses at 77 K was demonstrated. DOE

**N91-20259#** Los Alamos National Lab., NM.
**HIGH EFFICIENCY RESONANCE IONIZATION MASS SPECTROMETRIC ANALYSIS BY EXTERNAL LASER CAVITY ENHANCEMENT TECHNIQUES**
S. G. Johnson, E. L. Rios, C. M. Miller, and B. L. Fearey 1991 7 p Presented at the OE/LASE '91: 4th Society of Photo-Optical Instrumentation Engineers (SPIE) International Symposium, Los Angeles, CA, 20-25 Jan. 1991
(Contract W-7405-eng-36)
(DE91-007494; LA-UR-91-409; CONF-910123-5) Avail: NTIS HC/MF A02

The demand to measure high dynamic range isotope ratios on small samples with resonance ionization mass spectrometry (RIMS) continues to increase. This paper discusses high ionization efficiency methods which can be applied to continuous wave (CW) RIMS to potentially achieve several tens of percent ionization efficiencies for certain elements. The primary technique under development to achieve this is an external laser cavity which can generate very high circulating laser powers. DOE

**N91-20260#** Rice Univ., Houston, TX.
**INFRARED ABSORPTION SPECTROSCOPY AND CHEMICAL KINETICS OF FREE RADICALS**
R. F. Curl and G. P. Glass 1991 14 p
(Contract DE-FG05-85ER-13439)
(DE91-008282; DOE/ER-13439/6) Avail: NTIS HC/MF A03

A new channel producing ketenyl radical (HCCO) was discovered in the flash photolysis of ketene at 193 nm. H2CCO + h(nu)(193 nm) + H + HCCO by observation near 2020 cm(exp -1) of the infrared fundamental of ketenyl corresponding to the antisymmetric motion of the heavy atoms. This band has been partially rotationally analyzed and the rate constant for the reaction of ketenyl with NO has been determined. The OH stretching fundamental of hydroxymethyl radical (CH2OH) has been observed near 3600 cm(exp -1) producing the radical either by the excimer flash photolysis of acetol (CH3COCH2OH) or by Cl atom abstraction of a methyl hydrogen from methanol. The assignment of the spectrum to CH2OH was confirmed by the agreement of the rate constant for the reaction of the species with O2 with the literature value. The mechanism of the reaction of C2H with O2 has been explored. There appear to be two channels producing CO product: a fast, direct one producing highly vibrationally excited CO up to v = 6 at the same rate C2H disappears and a slow, indirect one producing primarily ground state CO on a much longer timescale than the disappearance of C2H. The rate constants for the reactions of C2H with CH4, C2H6, C2H4, D2, and CO were determined by following the time decay of a C2H infrared transient absorption line originating from the ground vibronic state using diode laser spectroscopy creating the C2H by excimer laser flash photolysis (ArF, 193 nm) of CF3CCH. The branching ratio into OH of the reaction between NH2, and NO, which is the channel thought to propagate the radical chain of the Thermal deNOx process, has been measured up to 925 C. The OH yield thus obtained appears to be too small to maintain the process. DOE

**N91-20261#** Yale Univ., New Haven, CT.
**COMPUTATIONAL AND EXPERIMENTAL STUDY OF LAMINAR FLAMES**
M. D. Smooke 1990 4 p
(Contract DE-FG02-88ER-13966)
(DE91-008548; DOE/ER-13966/2) Avail: NTIS HC/MF A01

A computational study was begun of nonpremixed tubular methane-air flames with detailed transport and finite rate chemistry. The multidimensional computation research was focused primarily on determining the structure of methane-air flames with C2 chemistry. Experimentally, the investigation was continued of axisymmetric laminar flames using laser imaging techniques. Varying the fuel/diluent ratio was studied. In methane flames, there is a broadband fluorescence that overlaps the Raman wavelengths used to measure the concentration of major species. DOE

**N91-20212*#** Rame-Hart, Inc., Mountain Lakes, NJ.
**CONTACT ANGLE DETERMINATION PROCEDURE AND DETECTION OF AN INVISIBLE SURFACE FILM**
G. Meyer and R. Grat *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 13-26 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 07D

**N91-20219*#** National Bureau of Standards, Gaithersburg, MD. Inst. for Materials Science and Engineering.
**THE KELVIN WATER-DROP EXPERIMENT**
Robert D. Shull *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 51-53 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 07D

**N91-20220*#** Buehler Ltd., Lake Bluff, IL.
**REVEALING THE MICROSTRUCTURE OF MATERIALS**
James A. Nelson *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 55-58 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 07D

**N91-20737*#** Nebraska Univ., Lincoln. Center for Microelectronic and Optical Materials Research.
**GROUND AND SPACE BASED OPTICAL ANALYSIS OF MATERIALS DEGRADATION IN LOW-EARTH-ORBIT**
John A. Woollam, Ron Synowicki, Jeffrey S. Hale, Jane Peterkin, Hassanayn Machlab, Bhola N. De, and Blaine Johs *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 772-777 (For primary document see N91-20702 12-59)
(Grant NAG3-95)
Avail: NTIS HC/MF A14 CSCL 07D

**N91-20738*#** Case Western Reserve Univ., Cleveland, OH. Center for the Commercial Development of Space.
**THE TRANSITION OF GROUND-BASED SPACE ENVIRONMENTAL EFFECTS TESTING TO THE SPACE ENVIRONMENT**
Stephen V. Zaat, Glen A. Schaefer, and John F. Wallace *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 778-784 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 07D

# 26 METALLIC MATERIALS

Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

**N91-20262** Department of the Navy, Washington, DC.
**METHOD OF SOLDERING ALUMINUM Patent**
Amarnath P. Divecha, inventor (to Navy), William A. Ferrando, inventor (to Navy), Philip W. Hesse, inventor (to Navy), and Subhash D. Karmarkar, inventor (to Navy) 25 Sep. 1990 3 p Filed 29 Aug. 1989
(AD-D014696; US-Patent-4,958,763; US-Patent-Appl-SN-401197; US-Patent-Class-228-193) Avail: US Patent and Trademark Office CSCL 11/6

An aluminum or aluminum alloy surface is coated with molten AgNO3, the silver nitrate is decomposed (at about 450 to 550 C) leaving a thin layer of silver metal, and then an inter-diffusion layer of silver and aluminum is formed (at about 570 to 660 C). The treated surface can be soldered by conventional means. Molten AgNO3 (MP 212 C) is coated on to the aluminum or aluminum alloy surface which is to be soldered. The molten AgNO3 is applied at a temperature above the melting point of AgNO3 but below the decomposition temperature of AgNO3. The surface is heated to keep the AgNO3 molten after it is applied. The molten AgNO3 wets and spreads out evenly over the aluminum surface. GRA

**N91-20263#** Centre Technique des Industries Mecaniques, Saint Etienne (France).
**MECHANICAL AND METALLURGICAL ASPECTS OF WARM TEMPERATURE FORCING Final Report [ASPECTS METALLURGIQUES ET MECANIQUES DE FORMAGE A MI-CHAUD. RAPPORT FINAL]**
M. Dunand, D. Forest, G. Metauer, Y. Perrin, P. Ravassard, and R. Blancon (SAFE, France ) May 1990 79 p In FRENCH
(CETIM-105430; ETN-91-98332) Copyright Avail: NTIS HC/MF A05

The advantages of warm temperature forging are outlined. Solutions to some of the practical application problems of the technique are presented. A better understanding of the mechanical and metallurgical behavior is obtained through traction, torsion and compression tests carried out at temperatures between 500 and 900C. The influence of parameters such as rate of heating, deformation rate, and strain direction is studied. The main lubricants available on the market are characterized by friction tests, ring tests and needle adhesion tests. The importance of lubrication in practical application of the warm forging techniques is stressed. ESA

**N91-20264*#** Clarkson Univ., Potsdam, NY. Center for Crystal Growth in Space.
**DIRECTIONAL SOLIDIFICATION OF Pb-Sn EUTECTICS WITH VIBRATION**
Rubens Caram, Mohsen Banan (MEMC Electronic Materials, Saint Peters, MO.), and William R. Wilcox [1991] 16 p Sponsored in cooperation with the Brazilian Agency for Scientific Development (CNPq)
(Grants NAG8-753; NAG8-541)
(NASA-CR-187942; NAS 1.26:187942) Avail: NTIS HC/MF A03 CSCL 11F

Pb-Sn eutectic alloy was directionally solidified at 1.4 to 3.2 cm/hr with forced convection induced by axial vibration of the growth ampoule with a frequency of 10 to 40 Hz and an amplitude of 0.5 to 1.0 mm. To determine the exact growth rate, an interface demarcation technique was applied. The lamellar spacing was increased 10 to 40 percent in ingots solidified with vibration compared to those solidified without vibration. The number of grain boundaries was increased by vibration. The average intensity of convection in the melt under axial vibration of the ampoule was estimated by comparing the experimental results with a theoretical model. Author

**N91-20265*#** Failure Analysis Associates, Inc., Redmond, WA.
**NONEQUILIBRIUM PHASE CHEMISTRY IN HIGH TEMPERATURE STRUCTURE ALLOYS Final Report, Jun. 1988 - Nov. 1990**
R. Wang Washington NASA Mar. 1991 161 p
(Contract NAS1-18693)
(NASA-CR-4353; NAS 1.26:4353) Avail: NTIS HC/MF A08 CSCL 11F

Titanium and nickel aluminides of nonequilibrium microstructures and in thin gauge thickness were identified, characterized and produced for potential high temperature applications. A high rate sputter deposition technique for rapid surveillance of the microstructures and nonequilibrium phase is demonstrated. Alloys with specific compositions were synthesized with extended solid solutions, stable dispersoids, and specific phase boundaries associated with different heat treatments. Phase stability and mechanical behavior of these nonequilibrium alloys were investigated and compared. Author

**N91-20266*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**SURFACE EFFECTS ON HYDROGEN PERMEATION THROUGH Ti-14Al-21Nb ALLOY**
Sandara N. Sankaran (Analytical Services and Materials, Inc.,

Hampton, VA.), Ronald A. Outlaw, and Ronald K. Clark Washington Apr. 1991 15 p
(NASA-TP-3109; L-16826; NAS 1.60:3109) Avail: NTIS HC/MF A03 CSCL 11F

Hydrogen transport through Ti-14Al-21Nb (wt percent) alloy is measured using ultrahigh vacuum permeation techniques over the temperature range of 500 to 900 C and hydrogen pressure range of 0.25 to 10 torr. Hydrogen permeability through the alloy can be described through two different mechanisms depending on th temperature of exposure. In the 675 to 900 C range, the process is diffusion-limited: the permeability has a weak temperature dependence, but the diffusivity has a strong temperature dependence. Below 675 C, the permeation rate of hydrogen is very sensitive to surface controlled processes such as the formation of a barrier layer from contaminants. A physical model explaining the role of surface films on the transport of hydrogen through Ti-14Al-21Nb alloy was described. Author

**N91-20267#** Kyoto Univ., Kumatori (Japan). Research Reactor Inst.
**EFFECTS OF NEUTRON IRRADIATION ON LOW TEMPERATURE STRENGTH OF ALUMINUM ALLOYS AND THEIR ELECTRON BEAM WELDED JOINTS**
Seiichi Kaga, Toshihiro Tamura, Hiroyuki Yoshida, and Kiyomi Miyata Jun. 1990 33 p In JAPANESE; ENGLISH summary
(DE91-744817; KURRI-TR-334) Avail: NTIS HC/MF A03

The effects of neutron irradiation on the mechanical properties of aluminum alloys were studied using a miniature tensile testing method. The aluminum alloys (A7NO1, A5083 and A6N01) for cryogenic structural materials were selected as the testing materials, and their base metals and electron beam welded joints were tested at cryogenic temperatures. Results from these tests are presented. DOE

**N91-20268*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**THERMOMECHANICAL AND BITHERMAL FATIGUE BEHAVIOR OF CAST B1900 + Hf AND WROUGHT HAYNES 188**
Gary R. Halford, Michael J. Verrilli, Sreeramesh Kalluri, Frank J. Ritzert, Rob E. Duckert (Wisconsin Univ., Madison.), and Frederic A. Holland Apr. 1991 22 p
(NASA-TM-4225; E-5601; NAS 1.15:4225) Avail: NTIS HC/MF A03 CSCL 11F

High temperature thermomechanical and bithermal fatigue behavior was investigated for two superalloys: cast nickel-base B1900+Hf and wrought cobalt-base Haynes 188. Experimental results were generated to support development of an advanced thermal fatigue life prediction method. Strain controlled thermomechanical and load-controlled, strain-limited, bithermal fatigue tests were used to determine the fatigue crack initiation and cyclic stress-strain response characteristics of superalloys. Bithermal temperatures of 483 and 871 C were used for B1900+Hf, and 316 and 760 C for Haynes 188. Thermomechanical fatigue tests were conducted by using maximum and minimum temperatures corresponding to those for the bithermal experiments. Lives cover the range from about 10 to 3000 cycles to failure. Isothermal fatigue results obtained previously are also discussed. Author

**N91-20269*#** Alabama Univ., Huntsville. Dept. of Mechanical Engineering.
**DEVELOPMENT OF AN OPTICAL FIBER INTERFEROMETER FOR DETECTION OF SURFACE FLAWS IN ALUMINUM Final Report**
John A. Gilbert Mar. 1991 20 p
(Grant NAG8-821)
(NASA-CR-186180; NAS 1.26:186180) Avail: NTIS HC/MF A03 CSCL 11F

The main objective was to demonstrate the potential of using an optical fiber interferometer (OFI) to detect surface flaws in aluminum samples. Standard ultrasonic excitation was used to generate Rayleigh surface waves. After the waves interacted with a defect, the modified responses were detected using the OFI and the results were analyzed for time-of-flight and frequency content to predict the size and location of the flaws. Y.S.

**N91-20270#** David Taylor Research Center, Bethesda, MD. Dept. of Ship Materials Engineering.
**MICROSTRUCTURAL FEATURES CONTROLLING DUCTILE-TO-BRITTLE TRANSITION BEHAVIOR IN HIGH-STRENGTH, MARTENSITIC STEEL WELD METALS**
J. J. DeLoach, Jr. Oct. 1990 122 p
(AD-A229948; DTRC/SME-89/79) Avail: NTIS HC/MF A06 CSCL 11/6

An investigation of the transition behavior of high strength steel, martensitic weld metals was conducted. The objective of the investigation was to identify the specific microstructural features that control ductile-brittle transition in these weld metals. The approach systematically combined experimental measurements and observations with the use of analytical expressions. Charpy V-notch (CVN) properties, tensile properties, and cleavage fracture stress (sigma c) were generated over a range of temperatures. The critical tensile stress criterion (CTSC) was applied in the form of a modified Griffith-Orowan expression. To establish the applicability of the CTSC to the transition regime, transition temperatures were predicted from sigma c measurements, and compared to measured CVN transition temperatures. GRA

**N91-20271#** Boeing Helicopter Co., Philadelphia, PA.
**AIRCRAFT QUALITY HIGH TEMPERATURE VACUUM CARBURIZING Final Report, Apr. 1982 - Feb. 1990**
R. J. Cunningham and R. J. Drago Nov. 1990 211 p
(Contract DAAG46-82-C-0034)
(AD-A229980; MTL-TR-90-42) Avail: NTIS HC/MF A10 CSCL 11/6

Development of a high temperature vacuum carburizing procedure for 9310 gear steel was accomplished during this program. Use of this procedure significantly reduced processing time of gears, which can lead to a reduction in acquisition costs. The procedure was utilized to process surface contact fatigue, single tooth bending fatigue, scoring, spur, and spiral bevel test gears. The data obtained from the testing and evaluation of these components was equal to or greater than similar data from conventionally carburized material. No significant variation in the vacuum carburized test data was observed from two mill heats of material. Following evaluation of these test gears, a spiral bevel input pinion gear was produced, vacuum carburized, and then tested in an actual helicopter transmission. Metallurgical evaluation of the tested gear showed that it met the same performance standards required of a conventionally carburized gear. In addition, a vacuum carburization procedure was investigated for the Vasco X2M alloy. Although a procedure for Vasco X2M was developed, it was not optimized. The data generated for this alloy is presented. GRA

**N91-20272#** Northwestern Univ., Evanston, IL.
**CONTROL OF NANOSTRUCTURES IN ULTRAHIGH-STRENGTH STEELS Final Report**
Gregory B. Olson 31 Aug. 1990 22 p
(Grant AF-AFOSR-0356-89; AF Proj. 2306)
(AD-A230097; Rept-0650-520-H407; AFOSR-90-1170TR) Avail: NTIS HC/MF A03 CSCL 11/6

The development of fine-scale multicomponent M2C carbides in AF1410 steel was observed as a function of time at the standard tempering temperature of 510 C. Strong departures from equilibrium compositions are observed at early stages of precipitation, and carbide composition appears to be particle size dependent in a given microstructure. Analysis of the carbide composition trajectory during precipitation in terms of the thermodynamic contributions of coherency and capillarity indicates initial nucleation at compositions of reduced interfacial energy but reduced chemical driving force. The ability of multicomponent carbides to follow a precipitation composition trajectory of increasing interfacial energy and increasing driving force appears important to the maintenance of a fine particle size and high number density at late stages of

precipitation for overaging resistance. Preliminary evidence is also found for predicted nonuniformity of the matrix composition in the stress field of a coherent particle. GRA

**N91-20273#** Texas Univ., Austin.
**UNDERSTANDING THE HIGH TEMPERATURE BEHAVIOR OF NIOBIUM ALUMINIDES: FIRST YEAR SUMMARY REPORT Annual Progress Report, 1 Dec. 1989 - 30 Nov. 1990**
John K. Tien 8 Nov. 1990 7 p
(Grant AF-AFOSR-0070-90; AF Proj. 2306)
(AD-A230202; UTSMRDL-TR-9001; AFOSR-90-1180TR) Avail: NTIS HC/MF A02 CSCL 11/6

The mechanical and physical properties of Niobium Aluminide intermetallics for high temperature aerospace applications were measured. NbAl3 was induction melted. Metallographic and chemical analysis was performed to confirm the composition and microstructure. The coefficient of thermal expansion was determined. Mechanical testing included elevated temperature elastic modulus and microhardness. Continuing work will focus on applying high temperature microhardness with varying load time to creep properties. Also, ingots of the two other intermetallic phases will be received shortly, with similar characterization to follow. Near-net shape processing may be used to form test specimens. A transmission electron microscopy effort will be used to identify deformation mechanisms. GRA

**N91-20274#** Army Armament Research, Development and Engineering Center, Watervliet, NY.
**UNUSUALLY HIGH FRACTURE TOUGHNESS OF ASTM A723 STEEL FROM A MIXED MARTENSITE/BAINITE MICROSTRUCTURE Final Report**
J. A. Kapp, J. Barranco, L. Meisel, P. J. Cote, and R. N. Wright Nov. 1990 18 p
(AD-A230315; ARCCB-TR-90032) Avail: NTIS HC/MF A03 CSCL 11/6

A mixed martensite/bainite microstructure in the high strength-low alloy steel (ASTM A723 pressure vessel steel) can be obtained by quenching from the austenitizing temperature to below M sub s, but above M sub f, and isothermally holding. As the supercooled austenite cools below M sub s, some martensite is formed and the isothermal hold results in the remainder of the untransformed austenite transforming to bainite. The resulting microstructure may be very fine depending on the prior austenite grain size. Since the martensite is formed first, the supercooled austenite between the martensite needles transforms to bainite during the isothermal hold. The resultant lamellar structure can result in remarkable fracture toughness with quite high strength (K sub Ic of 255 MP a sq m and ultimate tensile strength of 1200 MPa). In this report, the results of varying prior austenite grain size on strength and toughness and the strength-toughness relationship for the martensite/bainite mixture that may produce the highest toughness are presented. GRA

**N91-20275#** Virginia Univ., Charlottesville. Dept. of Materials Science.
**FUNDAMENTAL CONCEPTS RELATING LOCAL ATOMIC ARRANGEMENT DEFORMATION AND FRACTURE OF INTERMETALLIC ALLOYS Annual Technical Report, 1 Feb. 1990 - 1 Jan. 1991**
Edgar A. Starke, Jr. and John A. Wert Dec. 1990 10 p
(Grant AF-AFOSR-0143-90; AF Proj. 2306)
(AD-A230541; UVA/525723/MS90; AFOSR-90-1223TR) Avail: NTIS HC/MF A02 CSCL 11/6

The objective of this research program is to identify relationships between characteristics of intermetallic alloys at an atomic scale, the operation of slip and twinning deformation mechanisms at a microstructural scale, and bulk deformation and fracture properties. Our research focuses on two fundamental aspects of the problem of low toughness of intermetallic alloys: the role of deformation twinning in promoting ductility and toughness of ordered intermetallic alloys, and modeling the effect of dislocation characteristics on crack tip plasticity. GRA

**N91-20276#** Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Metallurgical Engineering and Materials Science.
**FUNDAMENTAL STUDIES OF BETA PHASE DECOMPOSITION MODES IN TITANIUM ALLOYS Annual Report, 30 Sep. 1989 - 30 Sep. 1990**
H. I. Aaronson, Y. Mou, and M. G. Hall 30 Nov. 1990 59 p
(Grant AF-AFOSR-0550-89; AF Proj. 2306)
(AD-A230550; AFOSR-90-1222TR) Avail: NTIS HC/MF A04 CSCL 11/6

Extensive efforts were made during this grant year to prepare generic overviews on major aspects of phase transformations. Topics on which overviews have been completed or are presently in progress as part of this activity include: crystallographic and mechanistic aspects of growth by shear vs. diffusional growth, interphase boundary structures formed during diffusional transformations in Ti-base alloys, a current summary of the technical bases for three different views of what constitutes bainite, a summary of the diffusionist views on the bainite reactions, the role of ledges in vapor-crystal, liquid-crystals and crystal-crystal phase transformations, a critique of Mats Hillerts' approach to the growth kinetics of diffusional transformations, and assessments of published studies on homogeneous nucleation kinetics in binary metallic alloys and atomic mechanism of diffusional nucleation and growth. GRA

**N91-20277*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**ELECTROCHEMICAL CORROSION STUDIES IN LOW CONDUCTIVITY MEDIA Final Report, 21 Jul. 1986 - 30 Aug. 1989**
G. D. Blue and C. M. Moran Nov. 1990 34 p
(AD-A230591; JPL-D-6709; AL-TR-89-062) Avail: NTIS HC/MF A03 CSCL 11/6

Because the reliability and compatibility of spacecraft components is of utmost importance in propulsion systems, there is a need for accurate and, preferably, short-term evaluation techniques. In this study, electrochemical impedance spectroscopy has been used to determine the corrosion rates of metals in liquid hydrazine. The electrochemical information was obtained in a relatively short time (hours) and the corrosion rates thus derived compared favorably with those obtained from the classical, real-time method. GRA

**N91-20278#** Grenoble-1 Univ. (France). Centre de Recherche en Electrochimie Minerale et en Genie des Procedes.
**CONTRIBUTION TO THE STUDY OF THE ELECTROCHEMICAL REFINING OF ZINC IN MOLTEN CHLORIDE ENVIRONMENT Ph.D. Thesis [CONTRIBUTION A L'ETUDE DU RAFFINAGE ELECTROCHIMIQUE DU ZINC EN MILIEU DE CHLORURES FONDUS]**
Majid Jafarian 1990 154 p In FRENCH
(ETN-91-98948) Avail: NTIS HC/MF A08

The LiCl-KCl-ZnCl2 melt is chosen as the electrolyte for zinc refinement. Acid/base properties and the electrical conductivity of the electrolyte are measured and presented. Potentiometric, convolutional voltamperometric and chronopotentiometric methods are used to study the electrochemical properties of the oxydoreducting compounds of zinc, cadmium and indium in LiCl-KCl and LiCL-KCl-ZnCl2 environments. The reversibility of electronic exchange reactions is demonstrated. The electronic potentials of such reactions are measured and presented. ESA

**N91-20279#** Royal Aerospace Establishment, Farnborough (England).
**VAPOUR DEPOSITED ALUMINIUM ALLOYS**
R. W. Gardiner 9 Aug. 1990 21 p Repr. from Materials and Design, v. 10, no. 6, Nov. - Dec. 1989 p 274-279
(RAE-TM-Mat/Str-1153; BR115503; ETN-91-99007) Copyright Avail: NTIS HC/MF A03

The vapor deposition process and the properties of an Al-Cr-Fe alloy produced by this process are described. Comparisons are made with some of the reported rapidly solidified alloys. The alloys

show advances in most properties but their further development (other than sheet) must await the availability of deposits from a larger scale facility. ESA

**N91-20280** National Physical Lab., Teddington (England). Div. of Materials Applications.
**REVIEW OF CORROSION STUDIES ON ALUMINIUM METAL MATRIX COMPOSITES**
Alan Turnbull Nov. 1990 31 p
(NPL-DMM(A)-145; ISSN-0959-2423; ETN-91-99022) Copyright Avail: National Physical Lab., Teddington, Middlesex, TW11 0LW, England

The published literature on corrosion of aluminum metal matrix composites based on silicon carbide, graphite, alumina and boron reinforcements is reviewed. In general, the composites are more susceptible to corrosion attack than the matrix alloy. Corrosion tends to be localized with galvanic couples, 'active' reaction products, increased density of intermetallic particles, microcrevices and voids cited as possible factors for specific composites. Research on corrosion fatigue and stress corrosion cracking is insufficient to permit detailed conclusions and further research is recommended. ESA

**N91-20281#** Purdue Univ., West Lafayette, IN. Heat Transfer Lab.
**MODELING OF DENDRITIC SOLIDIFICATION SYSTEMS: REASSESSMENT OF THE CONTINUUM MOMENTUM EQUATION AND APPLICATION TO SOLIDIFICATION OF A LEAD-TIN ALLOY**
P. J. Prescott and F. P. Incropera Feb. 1991 70 p
(Contract DE-FG02-87ER-13759)
(DE91-008228; DOE/ER-13759/4) Avail: NTIS HC/MF A04

In recent years there has been renewed interest in modeling transport phenomena associated with the dendritic solidification of binary mixtures. Solidification occurs in a two-phase (mushy) region characterized by complex, solid-liquid interfacial geometries, and development of a model which is amenable to solution dictates the use of continuum (mixture theory) assumption and/or volume-averaging procedures. A review of the recent literature would suggest that solidification models developed from mixture theory assumptions are less valid and less general than similar models based on volume-averaging, particularly with regard to the respective momentum equations which describe interdendritic fluid flow. In this report, these different approaches are shown to yield identical macroscopic conservation equations, and the continuum momentum equation is reconsidered in an effort to reconcile matters which have lead to confusion about the validity of the continuum model. Consistency between recently presented momentum equations is demonstrated. Using a continuum model for conservation of total mass, momentum, energy and species, numerical simulations of a binary metal alloy (Pb-Sn) undergoing solidification phase-change are performed. The system is contained in an axisymmetric, annular mold, which is cooled along its outer vertical wall. Results show that thermosolutal convection in the melt and mush zones is strongly coupled land that macrosegregation is reduced with increased cooling rate. For low cooling rates, solutally induced convection in the mushy zone favors the development of channels, which subsequently spawn macrosegregation in the form of A-segregates. With increasing solidification rate, however, thermosolutal interactions in the melt contribute to reducing the formation of channels and A-segregates. DOE

**N91-20282#** Lawrence Livermore National Lab., CA.
**FIRST PRINCIPLES CALCULATION OF PHASE STABILITY OF HIGH TEMPERATURE INTERMETALLIC ALLOYS**
J. Mikalopas, P. A. Sterne, M. Sluiter, and P. E. A. Turchi 18 Dec. 1990 8 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 26-29 Nov. 1990
(Contract W-7405-eng-48)
(DE91-008570; UCRL-JC-104594; CONF-901105-100) Avail: NTIS HC/MF A02

One way to calculate the coherent phase diagram of an alloy based on first principles methods is to compute the ground state total energy for various ordered configurations, from which many-body interactions can be calculated and employed in a thermodynamic model. If the Connolly and Williams method (CWM) is used to extract the many-body interactions from the calculated total energies, the resulting many-body interactions can exhibit a strong dependence on the choice of ordered configurations and multi-site clusters, and the accuracy and convergence of the CWM energy expansion is not assured. To overcome this difficulty, a successful systematic method for implementing the CWM is proposed. This approach is applied to a study of the fcc-based Ni-V and Pd-V substitutional alloys and these interaction parameters together with the cluster variation method (CVM) are used to calculate phase diagrams. DOE

**N91-20283#** Argonne National Lab., IL.
**LOCA ANALYSIS FOR MANGANESE-STABILIZED STEEL**
H. Attaya Sep. 1990 7 p Presented at the 9th Topical Meeting on Technology of Fusion Energy, Oak Brook, IL, 7-11 Oct. 1990
(Contract W-31-109-eng-38)
(DE91-008809; ANL/CP-70535; CONF-901007-62) Avail: NTIS HC/MF A02

Manganese-stabilized steels have been proposed as candidate structural materials for fusion reactors, because they have been perceived as low-activation materials. Depending on the neutron spectra and the neutron fluence, the decay heat in Mn-stabilized steels is about 3 to 7 times larger than that in the Ni-stabilized steels. This large amount of decay heat could have serious impact in the case of loss of coolant accident (LOCA). A two-dimensional LOCA model has been used to examine the LOCA temperature response of the manganese steel when utilized in an earlier U.S. design. The results show that the Mn-steel has approached its melting temperature by less than 100 C after about 7 hours from the onset of LOCA. On the other hand, the results for the nickel stabilized steel alloy 316SS show that the maximum temperature reached is 532 C in about the same time. DOE

**N91-20284*#** Case Western Reserve Univ., Cleveland, OH. Dept. of Materials Science and Engineering.
**GRAPHITE/COPPER ALLOY INTERFACIAL ENERGIES DETERMINED USING THE SESSILE DROP METHOD Final Report**
Sandra M. DeVincent, David L. Ellis, and Gary M. Michal Mar. 1991 10 p Presented at the 2nd International Ceramic Science and Technology Congress Symposium on Composites, Orlando, FL, 12-15 Nov. 1990; sponsored in part by American Ceramic Society
(Contract NCC3-94)
(NASA-CR-187087; E-6076; NAS 1.26:187087) Avail: NTIS HC/MF A02 CSCL 11F

Graphite surfaces are not wet by pure copper. This lack of wetting is responsible for a debonding phenomenon that was found in continuous graphite fiber/copper matrix composites materials subjected to elevated temperatures. By suitably alloying copper, its capability to wet graphite surfaces can be enhanced. In situ measurements of graphite/copper alloy wetting angles were made using the sessile drop method. Interfacial energy values were calculated based upon these measurements. Author

**N91-20109*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**OVERVIEW OF LEWIS MATERIALS RESEARCH: CONTRIBUTIONS, CURRENT EFFORTS, AND FUTURE DIRECTIONS**
Salvatore J. Grisaffe and Carl E. Lowell *In its* Aeropropulsion 1991 Mar. 1991 20 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 11F

**N91-20213*#** Erie Community Coll., Buffalo, NY.
**SENSITIZATION OF STAINLESS STEEL**
James P. Nagy *In* NASA, Langley Research Center, National

Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 27-30 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 11F

**N91-20216*#** Johns Hopkins Univ., Baltimore, MD.
**A DEMONSTRATION OF CHILL BLOCK MELT SPINNING OF METAL**
Robert B. Pond *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 37-39 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 11F

**N91-20218*#** National Bureau of Standards, Gaithersburg, MD. Inst. for Materials Science and Engineering.
**LOW CARBON STEEL: METALLURGICAL STRUCTURE VS. MECHANICAL PROPERTIES**
Robert D. Shull *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 47-50 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 11F

# 27 NONMETALLIC MATERIALS

Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials.

For composite materials see *24 Composite Materials.*

**N91-20285#** Japan Atomic Energy Research Inst., Tokyo.
**OPERATION AND CHARACTERISTICS OF VERY LOW TEMPERATURE IRRADIATION TEST EQUIPMENT**
Noboru Kasai and Tadao Seguchi Sep. 1990 41 p In JAPANESE; ENGLISH summary
(DE91-744834; JAERI-M-90-155) Avail: NTIS HC/MF A03

The very low temperature irradiation test equipment, which is used for the study of irradiation temperature effects on the radiation degradation of fiber reinforced plastics (FRP) and polymers, was constructed and installed in Takasaki Co-gamma irradiation facility in March 1989. The equipment has two types of irradiation vessel, liquid nitrogen and liquid helium. The Co-60 gamma-ray sources (18 pieces of pencil) were arranged cylindrically around the irradiation vessels. Initially, the test operation of the equipment was carried out, and the characteristics were investigated in the points of dose rate distribution and the regulation of liquid nitrogen and liquid helium supply during irradiation. The dose rate was 3.5x10(exp 6) R/h (9.0x10(exp 2) C/kg x h) in the vessel of liquid nitrogen, and 3.0x10(exp 6) R/h (7.7x10(exp 2) C/kg x h) in the vessel of liquid helium. The dose distribution was rather uniform in the vessel of liquid helium because of the small diameter. The evaporation of liquid helium increased during irradiation by about 30 times comparing with the nonirradiation. The transfer of liquid nitrogen and liquid helium from the storage tank to the irradiation vessel was well regulated during irradiation. DOE

**N91-20286#** State Univ. of New York, Buffalo. Dept. of Chemistry.
**TRANSIENT DYNAMICS IN EXCITONIC OPTICAL BISTABILITY IN POLYMERS**
Xinfu Xia, Xiao-Shen Li, D. L. Lin, and Thomas F. George Dec. 1990 21 p
(Contract N00014-90-J-1193)
(AD-A229901; UBUFFALO/DC/90/TR-32) Avail: NTIS HC/MF A03 CSCL 07/6

Transient behavior in optical bistability mediated by phonon mode and virtual exciton coupling is studied for an electron-phonon coupling system such as polydiacetylene-toluene-sulfonate. Numerical calculations are used to analyze the evolution between bistable states, and novel switching behavior and Rabi oscillations are found. GRA

**N91-20287#** Colorado State Univ., Fort Collins. Dept. of Chemistry.
**TEMPLATE SYNTHESIS OF CONDUCTING POLYMERS: ENHANCED CONDUCTIVITY, ENHANCED SUPERMOLECULAR ORDER, INTERESTING MICROSTRUCTURES**
C. R. Martin, Z. Cai, L. S. VanDyke, and W. Liang 7 Dec. 1990 5 p
(Contract N00014-82-K-0612)
(AD-A229931; TR-57) Avail: NTIS HC/MF A01 CSCL 20/3

Template synthesis entails the synthesis of an electronically conductive polymer within the pores of a microporous membrane. The membranes employed have cylindrical pores of equivalent pre diameter. These pores spatially-confine the synthesis and act as templates for the resulting polymer. Conductive polymer fibrils are obtained, where the fibril diameter is determined by the pore diameter. It is shown that these fibrils can be orders of magnitude more conductive than conventional films of the analogous polymer. Conductive polymer tubules can also be obtained in certain membranes. Conductivity, supermolecular order, and tubule synthesis are discussed. GRA

**N91-20288#** Illinois Univ., Urbana. Dept. of Materials Science and Engineering.
**TRANSFORMATION TOUGHENING OF COMPOSITE CERAMICS Annual Report, 1 Mar. 1989 - 30 Sep. 1990**
Waltraud M. Kriven 29 Oct. 1990 28 p
(Grant AF-AFOSR-0300-89; AF Proj. 2306)
(AD-A229933; UILU-ENG-90-5017; AFOSR-90-1186TR) Avail: NTIS HC/MF A03 CSCL 11/2

Research is underway into the application of martensitic transformations in ceramics to toughen a variety of ceramic-ceramic composites, i.e., to reduce their brittleness. The toughening agents of interest and their volume changes are dicalcium silicate (Ca2SiO4, 12 percent), nickel sulfide (NiS, 4 percent), lanthanide sesquioxides (Ln2O3, 8 percent) and lutentium borate (LuBO3, 8 percent). Ceramic processing routes have been developed to fabricate different types of toughened composites, viz., either by using a dispersed second phase microstructure or as a fine grained, single phase material. Specifically, Ca2SiO4 has been dispersed in CaZrO3 and the mechanical properties measured by bend tests. The critical importance of matrix toughness and grain size, as well as role of intergranular microcracking has been established. Dense pellets of fine grained, pure beta-Ca2SiO4 have been sintered and their transformability by grinding established. Their microstructures were examined by TEM and preliminary micromechanical studies made on it, and on Gd2O3, by indentation and SEM techniques. NiS inclusions in glass were examined by TEM and EDS and a sol gel processing route to precipitate NiS in glass has been identified. Composites of Dy2O3 in SiC and powders of LuBO3 in B2O3 have been fabricated. GRA

**N91-20289#** Massachusetts Inst. of Tech., Cambridge. Dept. of Chemistry.
**POLYMERIZATION OF FUNCTIONALIZED NORBORNENES EMPLOYING Mo(CH-t-Bu)(NAr)(O-t-Bu)2 AS THE INITIATOR**
G. C. Bazan, R. R. Schrock, H.-N. Cho, and V. C. Gibson 5 Dec. 1990 38 p
(Contract N00014-89-J-1542)
(AD-A230034; TR-11) Avail: NTIS HC/MF A03 CSCL 07/2

Norbornenes containing esters, cyano, acetate, and related functionalities can be polymerized in a living manner employing Mo(CH-t-Bu)(NAr)(O-t-Bu)2 as the initiator, especially in THF, to give polymers with polydispersities as low as 1.04. Living polymers containing Mo-alkylidene end groups have been characterized by proton NMR methods. GRA

**N91-20290#** Purdue Univ., West Lafayette, IN.
**PRODUCTION AND CHARACTERIZATION OF HIGH-ENERGY HYPERVALENT HYDRIDES Final Report, 1 Sep. 1987 - 31 Aug. 1990**
Edward R. Grant 21 Nov. 1990 14 p
(Contract F49620-87-C-0092)

(AD-A230094; AFOSR-90-1167TR) Avail: NTIS HC/MF A03 CSCL 20/5

Progress is described in a three-year program of research supported by AFOSR under the High-Energy-Density-Matter (HEDM) initiative. A laser-crossed molecular beam apparatus was constructed which is equipped to probe unique high-energy excited states by: (1) directly detecting anion photoproducts of charge-transfer intermediate excited states; (2) determining internal state distributions following photoionization of high-energy intermediates by time-of-flight photoelectron spectroscopy; and (3) characterizing ion-fragment distributions by time-of-flight mass spectroscopy. This instrument was employed in combination with a second, quadrupole molecular beam system to complete a set of experiments exploring structural and dynamical properties of high-energy matter. AFOSR supported experiments have detected anions arising from energetic charge-transfer configurations of monomeric HCl. Additional work on the same molecule, has probed intermediate-state effects on ion-fragment branching rations, and, by double-resonance, characterized the dynamics of rotationally state selected spin-orbit autoionization. GRA

**N91-20291#** State Univ. of New York, Buffalo. Dept. of Chemistry.

**SPECTRUM OF THE THIRD-ORDER NONLINEAR SUSCEPTIBILITY OF TRANS-POLYACETYLENE**

X. Sun, Z. Shuai, R. Fu, K. Nasu, and X. S. Li Dec. 1990 10 p
(Contract N00014-90-J-1193)
(AD-A230109; UBUFFALO/DC/TR-34) Avail: NTIS HC/MF A02 CSCL 20/5

By considering the finite lifetime of excitation and the band structure of a finite polymer chain, the two-peak structure in the spectrum of the third-order nonlinear susceptibility of trans-polyacetylene is calculated, with results in agreement with experiments. GRA

**N91-20292#** Massachusetts Univ., Amherst. Dept. of Polymer Science and Engineering.

**ULTRASTRUCTURE PROCESSING OF MACROMOLECULAR MATERIALS Final Report, 10 Oct. 1988 - 9 Feb. 1990**

Frank E. Karasz Nov. 1990 20 p
(Grant AF-AFOSR-0069-89; AF Proj. 2303)
(AD-A230175; AFOSR-90-1199TR) Avail: NTIS HC/MF A03 CSCL 07/6

In the investigations of polymer blends, efforts were continued in the areas of microstructural effects on miscibility in copolymers, of segmental interactions (hydrogen bonding) in high temperature blends and in solid state NMR studies of blend structure. In the studies of electrically and non-linearly active conjugated polymers, structural studies of poly-p-phenylene-vinylene and derivatives, blends, and analogues were emphasized. Ultrastructural processing investigations were emphasized on these materials as well as collaborative studies of the effect of processing on the optical properties. GRA

**N91-20293#** North Carolina State Univ., Raleigh.

**GROWTH, CHARACTERIZATION AND DEVICE DEVELOPMENT IN MONOCRYSTALLINE DIAMOND FILMS Annual Letter Report, 1 Jan. - 31 Dec. 1990**

Robert F. Davis, Jeffrey T. Glass, Klaus J. Bachmann, and R. J. Trew 31 Dec. 1990 61 p
(Contract N00014-90-J-1604)
(AD-A230186) Avail: NTIS HC/MF A04 CSCL 09/1

In this reporting period, diamond films have been deposited on various polycrystalline metal and (001) Si substrates by biased hot filament chemical vapor deposition, the films characterized by TEM, x-ray diffraction and Raman and Auger spectroscopies and MESFET devices modeled from the properties of diamond. In addition Cu single crystals were implanted at 900 deg C with C ions and other studies initiated in an attempt to achieve heteroepitaxial growth of diamond. Films grown on Si, Ni and W exhibited the highest quality diamond films from the viewpoint of Raman characterization. The model of the MESFET device with gate length = 1 micron and width = 1 mm showed that significant degradation in RF performance is not expected at 10 GHz. GRA

**N91-20294#** Southwest Research Inst., San Antonio, TX.

**CHARACTERIZATION OF MECHANICAL DAMAGE MECHANISMS IN CERAMIC AND POLYMERIC MATRIX COMPOSITE MATERIALS Technical Report, Oct. 1989 - Oct. 1990**

James Lankford and Herve Couque Oct. 1990 64 p
(Contract N00014-84-C-0123)
(AD-A230220; Rept-06-8124) Avail: NTIS HC/MF A04 CSCL 11/4

The principal objective of the program has been to establish the loading rate dependence of compressive deformation and fracture mechanisms in whisker and fiber-reinforced ceramic matrix composites, and in fiber-reinforced polymeric matrix composites. Work during the last year has emphasized several types of composites: silicon carbide fiber and silicon carbide whisker-reinforced pyroceram, and graphite fiber-reinforced thermoplastic. The behavior of a unidirectional carbon fiber-reinforced thermoplastic matrix composite subject to compressive loading is reported. Damage mechanisms are identified, and discussed in terms of matrix microstructure and fiber interactions. In particular, it is found that under quasi-static conditions, two absolutely critical factors control the life of the composite, i.e., the ability of the polymeric matrix to resist shear and thereby inhibit fiber flexure, and the ability of individual fibers to resist the nucleation of compressive plastic shear bands during flexure. It also is shown that at very high rates of strain (approx. 5000s to the minus 1), the strength suddenly begins to increase with strain rate in an extremely robust fashion. The measured strength-strain rate dependence in this range is shown to be consistent with the kinetics of kink band propagation. GRA

**N91-20295#** Aerospace Corp., El Segundo, CA. Lab. Operations.

**MICROPHASE-SEPARATION INTERPRETATION OF THE COVARIATION OF SEVERAL POLYURETHANE DIELECTRIC PROPERTIES**

R. S. Bretzlaff and R. Y. Sugihara 28 Sep. 1990 29 p
(Contract F04701-88-C-0089)
(AD-A230221; TR-0089(4935-03)-1; SSD-TR-90-36) Avail: NTIS HC/MF A03 CSCL 09/1

Electronic power supplies, cables and other equipment depend upon the breakdown-free separation of charged conductors. This often requires the use of polymeric encapsulants or extruded dielectrics, whose thermal aging behavior is a concern. One high-voltage encapsulation is the polyurethane, Uralane 5853. It is composed of chain molecules based on (1) polybutadiene, existing in a long, flexible subchain (soft segments), and (2) methylene diisocyanate, existing in a short, rigid subchain (hard segments) linking the flexible subchains. The hard segments in different chains tend to form hydrogen bonds and to phase separate. This work demonstrates the relation of Uralane's dielectric breakdown strength to its permittivity (50 Hz to 10 kHz) and to its dc conductivity, thereby illustrating an analytical technique for use in the formulation and evaluation of new polyurethanes. It was found that the (partially reversible) reduction in paracrystalline domain size correlated with a decrease in dielectric breakdown strength during thermal aging. All other things being equal, increased phase separation leads to diminished leakage current through the dielectric, with fewer energetic electrons available to possibly initiate failure during electrical aging. Testing is in progress on a new series of polyurethanes in order to ascertain the optimum hard-segment composition for thermal-aging voltage stability. GRA

**N91-20296#** Arkansas Univ. for Medical Sciences, Little Rock.

**NMR IMAGING OF ELASTOMERIC MATERIALS Annual Report, 1 Jul. 1989 - 31 Jul. 1990**

Richard A. Komoroski, Subhendra N. Sarkar, and E. W. Wooten 30 Nov. 1990 43 p

(Grant AF-AFOSR-0418-89; AF Proj. 2306)
(AD-A230299; AFOSR-90-1185TR) Avail: NTIS HC/MF A03 CSCL 20/5

NMR imaging has been applied to some elastomeric materials of industrial and military interest. The T2 spin-spin relaxation times of common elastomers, particularly after filling and curling, are sufficiently short that spin-echo sequences at submillisecond echo times cannot produce T2-independent images. The sensitivity to T2 potentially makes spin echo imaging a good probe of elastomer blend composition, as demonstrated for a series of filled and cured cis-polybutadiene, styrene-butadiene rubber blends. The technique can be used to distinguish good and bad carbon black dispersion in actual tire tread samples. The configuration of polyester tire cord, voids, rubber layer boundaries, apparent migration of additives, and other inhomogeneities can be detected in end-product tire samples. NMR images have been obtained for four porous glass disks of different porosities as models of materials such as oil cores. The mottled appearance often seen for such images is attributed largely to insufficient signal-to-noise ratio, and not pore structures. Comparison of spin-echo and gradient-echo images demonstrates the defect-magnification effect of the gradient-echo. GRA

**N91-20297#** Army Lab. Command, Watertown, MA. Material Technology Lab.
**HOT ISOSTATIC PRESSING OF SUPERCONDUCTING CERAMICS Final Report**
Kerry T. Richards and Richard H. Benfer Oct. 1990 23 p
(AD-A230355; MTL-TR-90-51) Avail: NTIS HC/MF A03 CSCL 20/3

Hot isostatic pressing (HIP) was studied as a method for processing bulk superconductors. Superconducting powder was derived from the calcination of nitrated Y2O3, CuO, and BaCO3 powder. The powder was pressed using pressures of 70, 140, and 210 MPa with temperatures of 820 and 950 C for a hold time of 1 hour. The density, hardness and Young's modulus of pressed samples were higher than those of sintered control samples. Superconducting transition temperatures 92 K were achieved without post-HIP annealing of the samples. GRA

**N91-20298#** Southwest Research Inst., San Antonio, TX.
**STUDY OF HIGH TEMPERATURE FAILURE MECHANISMS IN CERAMICS Annual Report, Dec. 1989 - Nov. 1990**
Richard A. Page, James Lankford, and Kwai S. Chan Nov. 1990 62 p
(Contract F49620-88-C-0081)
(AD-A230361; SwRI-2253/2; AFOSR-90-1204TR) Avail: NTIS HC/MF A04 CSCL 11/2

This annual report documents the results of a basic research program aimed at the following: (1) studying the high temperature failure mechanisms in ceramics; (2) establishing relationships between cavitation mechanisms and creep crack growth characteristics; and (3) developing a damage mechanism-based life prediction model. During the reporting period, the growth rate, near-tip creep responses, and damage processes of creep cracks in a pyroceram glass-ceramic were studied under tensile loading at elevated temperatures. The results of these studies indicated that creep crack growth in the pyroceram glass-ceramic occurred both in continuous and discontinuous manners, with the damage processes manifested as the nucleation, growth, and coalescence of inhomogeneously distributed cavities and microcracks. Sintering of cavities led to the existence of a growth threshold below which the creep crack would open, blunt, but not propagate. Measurements of the total accumulated creep strain near the crack-tip revealed that creep crack extension followed a critical strain criterion. Relationships between cavitation mechanisms and creep crack growth characteristics of the glass-ceramic are discussed. GRA

**N91-20299#** Massachusetts Univ., Amherst. Dept. of Science and Engineering.
**A CENTER FOR ADVANCED ELECTRICAL AND STRUCTURAL POLYMERS Final Report, 1 Nov. 1988 - 30 Dec. 1989**
Frank E. Karasz Nov. 1990 38 p
(Contract F49620-89-C-0027)
(AD-A229744; AFOSR-90-1161TR) Avail: NTIS HC/MF A03 CSCL 07/6

The fourth thrust has sought to elaborate on novel macromolecular architectures and characterization and the fifth thrust comprises new processing technologies and is largely centered on FMI investigations of PPV film processing optimization and on the difficult problem of larger scale processing of semi-intractable high temperature blends. GRA

**N91-20300#** Israel Inst. of Metals, Haifa.
**LASER AND ELECTROCHEMICAL STUDIES OF METALLIZATIONS IN ELECTRONIC DEVICES Final Report, 1 Sep. 1988 - 31 Aug. 1989**
J. Zahavi and M. Rotel Oct. 1990 49 p
(Grant AF-AFOSR-0315-86)
(AD-A229747; Rept-504-591; WRDC-TR-90-4099) Avail: NTIS HC/MF A03 CSCL 11/3

Irradiation of a Pb/Sn coating with excimer laser at 193nm with power density of 0.5 to 0.7 J/p/sq cm resulted in producing surface melting. Pb-rich particles were found before and after laser treatment. Increasing the laser energy level as well as increasing the repetition rate resulted in decreasing the size of these particles. Corrosion studies by potentiodynamic technique show that the corrosion potential changed in the noble direction when the repetition rate and laser energy were increased. The laser-treated area did not corrode although the as-deposited adjacent area did. Corrosion occurred by general mode corrosion while lead was preferentially dissolved. GRA

**N91-20301#** Case Western Reserve Univ., Cleveland, OH. Dept. of Macromolecular Science.
**MOLECULAR ENGINEERING OF LIQUID CRYSTALLINE POLYMERS BY LIVING POLYMERIZATION. 10: INFLUENCE OF MOLECULAR WEIGHT ON THE PHASE TRANSITIONS OF POLY(OMEGA-((4-CYANO-4'-BIPHENYL)OXY)ALKYL VINYL ETHER)s WITH NONYL AND DECANYL ALKYL GROUPS**
Virgil Percec and Myongsoo Lee 16 Oct. 1990 36 p Submitted for publication
(Contract N00014-89-J-1828)
(AD-A229768; TR-41) Avail: NTIS HC/MF A03 CSCL 07/3

The first goal of this series of publications is to provide a complete elucidation of the influence of molecular weight on the phase behavior of poly(omega-((4-cyano 4'-biphenyl)oxy)alkyl vinyl ether)s containing alkyl groups from ethyl to undecanyl. The goal of this paper is to describe the synthesis and living cationic polymerization of the last two monomers from this series, i.e., 9-((4-cyano 4'-biphenyl)oxy)nonyl vinyl ether (609) and 10-((4-cyano 4'-biphenyl)oxy)decanyl vinyl ether (6-10). The influence of molecular weight on their phase transitions will be discussed by comparison to that of 9-((4-cyano 4'-biphenyl)ocy)decanyl ethyl ether (8-10) and 10-((4-cyano 4'biphenyl)oxy)decanyl ether ether (8-10) which represents the model compounds of the monomeric structural units of poly (6-9) and poly (6-10). Then, the mesomorphic behavior of poly(omega-((4-cyano 4'-biphenyl)oxy)alkyl vinyl ether)s with alkyl groups containing from two to eleven methylenic units will be comparatively discussed at four different degrees of polymerization: 30, 23, 13 and 4. The implication of different phase transitions at various molecular weights on the molecular design of novel macromolecular architectures based on side charm liquid crystalline polymers is briefly discussed. GRA

**N91-20302#** Case Western Reserve Univ., Cleveland, OH. Dept. of Macromolecular Science.
**MOLECULAR ENGINEERING OF LIQUID CRYSTALLINE POLYMERS BY LIVING POLYMERIZATION. 9: LIVING CATIONIC POLYMERIZATION OF 5-((4-CYANO 4'-BIPHENYL)OXY)PENTYL VINYL ETHERS AND 7-((4-CYANO 4'-BIPHENYL)OXY)HEPTYL VINYL ETHER AND THE MESOMORPHIC BEHAVIOR OF THE RESULTING POLYMERS**
Virgil Percec, Myongsoo Lee, and C. Ackerman 16 Oct. 1990

31 p
(Contract N00014-89-J-1828)
(AD-A229769; TR-40) Avail: NTIS HC/MF A03 CSCL 07/3

The synthesis and living cationic polymerization of 5-((4-cyano 4'-biphenyl)oxy)pentyl vinyl ether (6-5) and 7-((4-cyano 4'biphenyl)oxy)heptyl vinyl ether (6-7) are presented. The influence of molecular weight on the mesomorphic behavior of poly(6-5) and poly(6-7) is discussed and compared to that of 5-((4-cyano 4'-biphenyl)oxy)pentyl ethyl ether (8-5) and 7((4-cyano 4' biphenyl)oxy)heptyl ethyl ether (8-7) which are models of the monomeric structural units of poly(6-5) and poly(6-7). Both (8-5) and (8-7) exhibit a monotropic nematic mesophase. GRA

**N91-20303#** Case Western Reserve Univ., Cleveland, OH. Dept. of Macromolecular Science.

**MOLECULAR ENGINEERING OF LIQUID CRYSTALLINE POLYMERS BY LIVING POLYMERIZATION. 8: INFLUENCE OF MOLECULAR WEIGHT ON THE PHASE BEHAVIOR OF POLY(OMEGA-((4-CYANO 4'BIPHENYL)OXY)ALKYL VINYL ETHER)s WITH ETHYL, PROPYL, AND BUTYL ALKYL GROUPS**

Virgil Percec and Myongsoo Lee 16 Oct. 1990 31 p
(Contract N00014-89-J-1828)
(AD-A229770; TR-39) Avail: NTIS HC/MF A03 CSCL 07/3

The investigations on the polymerization of mesogenic vinyl ethers are performed with the initiating system CF3SO3H/(CH3)2S which induces a living polymerization at 0 C in methylene chloride. Presently, experiments are being performed which provide a complete understanding of the influence of molecular weight on the phase behavior of poly(omega-((4-cyano 4'-biphenyl)oxy)alkyl vinyl ether)s with flexible spacers containing from two to eleven methylene units. This paper will describe the results on the influence of molecular weight on the behavior of poly(2-((4-cyano 4'-biphenyl)oxy)ethyl vinyl ether (6-2), poly(3-((4-cyano 4'-biphenyl)oxy)propyl vinyl ether) (6-3) and poly(4-((4-cyano 4'-biphenyl)oxy)butyl vinyl ether) (6-4). Their phase behavior will be compared to that of the model compounds of their monomeric structural units. GRA

**N91-20304#** Case Western Reserve Univ., Cleveland, OH. Dept. of Macromolecular Science.

**MOLECULAR ENGINEERING OF LIQUID CRYSTALLINE POLYMERS BY LIVING POLYMERIZATION. 7: INFLUENCE OF COPOLYMER COMPOSITION ON THE PHASE BEHAVIOR OF POLY(11-((4-CYANO-4'BIPHENYL)OXY)UNDECANYL VINYL ETHER-CO-2-((4-CYANO-4'-BIPHENYL)OXY)ETHYL VINYL ETHER)**

Virgil Percec and Myongsoo Lee 16 Oct. 1990 10 p
(Contract N00014-89-J-1828)
(AD-A229771; TR-38) Avail: NTIS HC/MF A02 CSCL 07/3

This paper describes the synthesis of poly(11-(4-cyano 4'-biphenyl)oxy)undecanyl vinyl ether-co-2-((4-cyano-4'biphenyl)oxy)ethyl vinyl ether A/B(poly(6-11)-co-(6-2))A/B where A/B refers to the molar ratio between the monomers 6-11 and 6-2, with number average molecular weights above 15, by living cationic polymerization. The phase behavior of the resulting copolymers was discussed as a function of copolymer composition. Within this range of molecular weights, in the first heating scan poly(6-11) exhibits a melting and an enantiotropic s(sub A) phase, while poly(6-2) an inverse s(sub C). In the second and subsequent heating scans poly(6-11) displays an enantiotropic s(sub X) (unidentified smectic phase) and a s(sub A) mesophase, while poly(6-2) only a glass transition temperature. Depending on composition, poly((6-11-co-6-2))A/B either display an enantiotropic nematic, enantiotropic s(sub A) or both enantiotropic nematic and anantiotropic s(sub A) phases. GRA

**N91-20305#** Case Western Reserve Univ., Cleveland, OH. Dept. of Macromolecular Science.

**MOLECULAR ENGINEERING OF LIQUID CRYSTALLINE POLYMERS BY LIVING POLYMERIZATION. 6: INFLUENCE OF MOLECULAR WEIGHT ON THE PHASE TRANSITIONS OF A 1/1 COPOLYMER OF 2-((4-CYANO 4'-BIPHENYL)OXY)ETHYL VINYL ETHER AND 8-((4-CYANO 4'-BIPHENYL)OXY)OCTYL VINYL ETHER**

Virgil Percec and Myongsoo Lee 16 Oct. 1990 10 p
(Contract N00014-89-J-1828)
(AD-A229772; TR-37) Avail: NTIS HC/MF A02 CSCL 07/3

A 1/1 molar ratio of 2-((4-cyano 4'-biphenyl)oxy)ethyl vinyl ether (6-2) and 8-((4-cyano 4'biphenyl)oxy)octyl vinyl ether (6-8) was cationically copolymerized with the initiating system CF3SO3H/(CH3)2S in methylene chloride at 0 C. All copolymers present narrow molecular weight distributions, and number average molecular weights which exhibit a linear dependence on Msub zero/Isub zero. Copolymers with degrees of polymerization lower than 14 exhibit an enantiotrpic nematic mesophase regardless of the thermal history of the sample. Copolymers with higher molecular weights exhibit an inverse monotropic smectic-A and an enantiotropic nematic mesophase in the first heating scan and only enantiotropic nematic mesophase in the subsequent heating scans. GRA

**N91-20306#** Case Western Reserve Univ., Cleveland, OH. Dept. of Macromolecular Science.

**MOLECULAR ENGINEERING OF LIQUID CRYSTALLINE POLYMERS BY LIVING POLYMERIZATION. 5: SYNTHESIS AND MESOMORPHIC BEHAVIOR OF POLY(2-(4-CYANO-4'-BIPHENYL)OXY)ETHYL VINYL ETHER-CO-8-(4-CO-4'-BIPHENYL)OXY)OCTYL VINYL ETHER)**

Virgil Percec and Myongsoo Lee 16 Oct. 1990 28 p
(Contract N00014-89-J-1828)
(AD-A229773; TR-36) Avail: NTIS HC/MF A03 CSCL 07/3

The synthesis and characterization of poly(2-((4-cyano 4'-biphenyl)oxy)ethyl vinyl ether) poly(6-2), poly(8-((4-cyano 4'biphenyl)oxy)octyl vinyl ether) (poly(6-8)), and poly(6-2-co6-8) X/Y (where X/Y is the molar ratio of the two monomericstructural units) with degrees of polymerization of about 10 and narrow molecular weight distribution are described. Both homopolymers and copolymers were prepared by living cationic polymerization and copolymerization of 6-2 and 6-8. During the first heating scan poly(6-2) presents an inverse monotropic s(sub C) mesophase. During subsequent heating and cooling scans, this polymer is amorphous regardless of the thermal history of the sample. Poly(6-8) exhibits an enantiotropic s(sub A) mesophase. Both during the first and subsequent heating and cooling scans, the phase diagram which plots the dependence of mesomorphic transition temperatures as a function of copolymer composition presents a discontinuity. GRA

**N91-20307#** Israel Inst. of Metals, Haifa.

**LASER AND ELECTROCHEMICAL STUDIES OF METALLIZATIONS ELECTRONIC DEVICES Interim Technical Report, Sep. 1987 - Aug. 1988**

J. Zahavi, M. Rotel, and B. Dobbs Oct. 1990 81 p
(Grant AF-AFOSR-0315-86)
(AD-A229801; Rept-2-504591; WRDC-TR-90-4098) Avail: NTIS HC/MF A05 CSCL 11/3

In the current study a major effort was conducted in finding suitable methods of metallization of superconductor Y-Ba-Cu-O base ceramic material to form low ohmic contact resistance without annealing and masking procedure. The authors introduced the procedure of laser induced metallization from plating solution on immersed substrate without the need of external power and masking procedure. The feasibility of laser induced high speed, high selective metal (gold) deposit from nonaqueous gold plating solution on superconductive ceramic material was shown. Patterned metallization of gold deposit show low resistance ohmic contact which decreases with decrease of temperature. GRA

**N91-20308#** Queens Univ., Belfast (Northern Ireland). Dept. of Applied Mathematics and Theoretical Physics.
**IONIZATION AND NEUTRALIZATION PROCESSES Technical Report, 1 Apr. 1989 - 31 Mar. 1990**
David R. Bates 29 Apr. 1990 16 p
(Grant AF-AFOSR-0190-88; AF Proj. 2303)
(AD-A230572; GL-TR-90-0229; SR-1) Avail: NTIS HC/MF A03 CSCL 07/4

Dissociative recombination in polyatomic ions is discussed. A new process, tidal termolecular ionic recombination has been discovered. Deactivation of O2 by N2 is discussed in connection with termolecular association of oxygen. The temperature-dependence of termolecular association has been explained. An experimentally-determined rate of N(2D) quenching by O(3P) is shown to be incompatible with forbidden-red-line observations. Transition probabilities for some 2 bands have been computed. The O(1S) production-mechanisms, relevant to observations on the nocturnal F-region, are discussed. GRA

**N91-20309#** Stanford Univ., CA. High Temperature Gasdynamics Lab.
**FIRST ORDER RAMAN SPECTRUM OF DIAMOND AT HIGH TEMPERATURES**
Harald Herchen and Mark A. Cappelli 22 Dec. 1990 22 p
(Contract N00014-89-J-1197)
(AD-A230625; TR-6) Avail: NTIS HC/MF A03 CSCL 07/2

Measurements of the first order Raman spectrum in natural type IIa diamond for the temperature range of 293 to 1850 K are presented. Both the Stokes and anti-Stokes components are analyzed for their intensity, Raman shift, and width variation with temperature. Optical pyrometry was used to make the temperature measurements, the results of which were independently confirmed by the Stokes to anti-Stokes intensity ratios. The shift and width variations with temperature are in general agreement with the molecular dynamics simulation of C.Z. Wang, C.T. Chan, and K.M. Ho. Heating of the samples to temperatures as high as 1850 K in vacuo could be performed without any evidence of polymorphic conversion to graphite, also in agreement with previous investigations. GRA

**N91-20310#** Army Lab. Command, Watertown, MA. Material Technology Lab.
**MODEL ADHEREND SURFACE EFFECTS ON EPOXY CURE REACTIONS Final Report**
Walter X. Zukas, Kelly J. Craven, and Stanley E. Wentworth Nov. 1990 24 p
(AD-A230710; MTL-TR-90-58) Avail: NTIS HC/MF A03 CSCL 11/1

Adherend surface effects on the amine cure of epoxy resins were investigated using finely divided aluminum oxide as high surface area models for aluminum. Calorimetric analysis of simplified crosslinking systems revealed significantly faster reactions which led to lower glass transition temperature materials for activated aluminum oxide filled samples. A monofunctional amine and epoxy were then utilized to obtain soluble reaction products amenable to molecular characterization. These studies similarly showed an increase in the rate of epoxy consumption in the presence of activated aluminum oxide which was attributed to both an increase in the rate of amine addition to epoxy, as well as to epoxy homopolymerization. The latter was not observed in the unfilled mixtures. Such changes in reaction mechanism at the adherend surface have implications for the strength and durability of actual adhesive bonds. GRA

**N91-20311#** Department of the Navy, Washington, DC.
**A MACHINABLE OXIDE CERAMIC Patent Application**
Roy Rayne, inventor (to Navy), Lou Toth, inventor (to Navy), Dave Jones, inventor (to Navy), and Bob Soulen, inventor (to Navy) 25 Jun. 1990 10 p
(AD-D014752; US-Patent-Appl-SN-543132) Avail: NTIS HC/MF A02 CSCL 20/3

Accordingly, it is an object of this invention to form a machinable high Tc ceramic superconductor. It is also an object of this invention to provide a method of forming a high Tc ceramic superconductor. It is also an object of this invention form a high critical temperatures (Tc) ceramic superconductor with randomly oriented platelet microstructure. These and other objects of the invention are accomplished by weighing and mixing appropriate stoichiometric amounts of Bi2O2, SrCO3, CaCO3, and CuO (BSCCO), removing carbonates from the mixture, melting the mixture, casting the melted mixture into a mold, and inducing superconductivity and growth of randomly oriented platelets in the cast. GRA

**N91-20312** National Physical Lab., Teddington (England). Div. of Materials Applications.
**DYNAMIC MECHANICAL PROPERTIES AND MORPHOLOGY OF A POLYETHYLENE/POLYCARBONATE BLEND**
P. E. Tomlins and B. E. Read Aug. 1990 23 p
(NPL-DMM(A)-11; ISSN-0959-2423; ETN-91-99020) Copyright Avail: National Physical Lab., Teddington, Middlesex, TW11 0LW, England

Comparisons between the measured temperature dependence of the dynamic mechanical properties of a blend of polycarbonate with linear low density polyethylene and predictions based on equations obtained for composite models are made. The values of the parameters used in these equations yield information concerning the morphology of the blend which is consistent with that observed by microscopy. ESA

**N91-20313** National Physical Lab., Teddington (England). Div. of Materials Applications.
**CREEP AND PHYSICAL AGEING IN PVC AT HIGH STRESSES**
G. D. Dean, B. E. Read, J. L. Lesniarek-Hamid, and P. E. Tomlins Dec. 1990 29 p
(NPL-DMM(A)-17; ISSN-0143-7313; ETN-91-99024) Copyright Avail: National Physical Lab., Teddington, Middlesex, TW11 0LW, England

The creep behavior of PolyVinyl Chloride (PVC) was investigated under elevated stresses where the creep strain is no longer linearly related to the applied stress. As with linear behavior, the creep deformation is observed to be dependent upon the state of physical aging of the polymer. The main effect of nonlinear stresses is an initial rapid reduction in the mean retardation time for the creep process which is broadly equivalent to a horizontal shift of linear creep curves to shorter times. There is however also a significant change with stress to the shape of the linear curve and a small increase in the short time, limiting compliance. These effects are consistent with a reduction in the state of physical aging of the polymer brought about by the application of the elevated stress. At longer times, the mean retardation time is shown to increase with time suggesting a reactivation of physical aging. A model, developed to describe linear creep behavior in plastics was extended to include the influence of nonlinear stresses. Relationships are proposed defining the dependence of parameters in the model upon stress and the initial state of physical aging of that specimen. These are then used to develop a compliance function enabling the prediction of nonlinear behavior. ESA

**N91-20314** National Physical Lab., Teddington (England). Div. of Materials Applications.
**BIAXIAL STRENGTH TESTS ON BIOCERAMIC MATERIALS**
W. P. J. Byrne and R. Morell Dec. 1990 19 p
(NPL-DMM(A)-18; ETN-91-99025) Copyright Avail: National Physical Lab., Teddington, Middlesex, TW11 0LW, England

Ring on ring biaxial fracture tests were performed on a bioceramic material, 'Vitox', with a view to examining the effect of inserting packing materials between the specimen and the loading and support rings, as proposed in the draft revision of ISO 6474, implants for surgery. A secondary objective was to determine the strength level achieved in this test by 'Vitox'. A number of permutations of surface finish and packing arrangements were examined. The low Weibull modulus obtained in the tests threw some doubt on the statistical significance of the results, but it appears that the packing materials have a major influence on the strength levels measured, presumably by reducing the effects of friction and slight out of flatness of the specimens or loading ring

surfaces. In all cases, 'Vitox' exceeded the minimum strength levels proposed by the standard, albeit on slightly smaller specimens than specified. ESA

**N91-20315#** IIT Research Inst., Bartlesville, OK. National Inst. for Petroleum and Energy Research.
**EFFECTS OF DEGREE OF HYDROLYSIS AND SHEAR ON GELATION REACTION KINETICS AND GEL STRENGTH**
Hong W. Gao Feb. 1991 20 p
(Contract DE-FC22-83FE-60149)
(DE91-002225; NIPER-488) Avail: NTIS HC/MF A03

Gelation tests were conducted to investigate the effect of the degree of hydrolysis on gelation reaction kinetics and gel strength using four low-molecular-weight polyacrylamides (MW = 400,000 daltons), which were 10 percent (HPAM1-10), 20 percent (HPAM1-20), 30 percent (HAPM1-30), and 40 percent (HPAM-40) hydrolyzed, and Cr-3 (pH = 4.8) and Al-3 (pH = 7.0) crosslinkers. Results showed that for polymer/Cr-3 gel systems, samples prepared with a low-molecular-weight polyacrylamide polymer, which was 20 percent hydrolyzed, gelled at a faster rate and retained higher gel strength than those prepared with a low-molecular-weight polyacrylamide polymer, which was 10 percent hydrolyzed. Under the screening condition, no viscosity enhancement was observed in samples prepared with polymers having a degree of hydrolysis equal to or greater than 30 percent. For polymer/Al-3 gel systems, samples prepared with a low-molecular-weight polyacrylamide polymer, which was 20 percent hydrolyzed, gelled at the fastest rate and retained the strongest gel strength among the polymer/Al-3 gel systems prepared with four low-molecular-weight polyacrylamide polymers, which were 10, 20, 30, and 40 percent hydrolyzed, respectively. Gelation tests of gel systems in glass bead packs showed that high shear favored the gelation of a gel system that had a fast rate of gelation, but had an adverse effect on the gelation of three gel systems that had a slow rate of gelation. Weak gels were found to be injectable through porous media. Weak gels were degradable under high shear condition and regained viscosity under low shear conditions. DOE

**N91-20316#** Utah Univ., Salt Lake City. Dept. of Physics.
**PHOTOMODULATION SPECTROSCOPY OF PHOTOCARRIER DYNAMICS, ELECTRONIC DEFECTS AND MORPHOLOGY OF CONDUCTING POLYMERS Progress Report**
Z. V. Vardeny 16 Jan. 1991 9 p
(Contract DE-FG02-89ER-45409)
(DE91-007977; DOE/ER-45409/1) Avail: NTIS HC/MF A02

This is a progress report on the first 18 months of activities associated with the DOE grant to the Physics Department of the University of Utah, starting October 1989, on photocarrier dynamics, electronic defects and morphology of conducting polymers using the photomodulation spectroscopy. During the first period of this grant we have already achieved impressive results and have started new studies, to be completed during the grant continuation period of the second year. We will describe our progress according to the material studied, since this is the best method to summarize our accomplishments. We have used a variety of techniques in our studies such as: CW photomodulation, photomodulation in the femtosecond and picosecond time ranges, CW resonant Raman scattering, transient photoinduced Raman scattering, electro-absorption and degenerate four-wave mixing. These techniques have been used to obtain the transient electronic response of the studied conducting polymers. DOE

**N91-20317#** Pennsylvania State Univ., University Park. Dept. of Materials Science and Engineering.
**FRACTURE BEHAVIOR OF SURFACE-MODIFIED CERAMICS**
D. J. Green Jan. 1991 6 p
(Contract DE-FG02-86ER-45252)
(DE91-008841; DOE/ER-45252/T5) Avail: NTIS HC/MF A02

The overall objective of this work is to understand crack growth on surfaces that are being acted on by macroscopic residual stresses. In the current year work has been performed in 3 areas: (1) fracture behavior of ion-exchanged glasses; (2) fracture of SiC-coated graphite; and (3) sub-critical crack growth in ion-exchanged glasses. The work in the first two of these areas will be complete by the end of the current funding year and the third project was initiated in September 1990. DOE

**N91-20107*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**TRANSITION-TO-PRACTICE TECHNOLOGIES FOR BRITTLE MATERIALS**
Edward R. Generazio *In its* Aeropropulsion 1991 Mar. 1991 18 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 11C

**N91-20222*#** Pacific Northwest Lab., Richland, WA. Richland Schools.
**MAKING AND TESTING SUPERCONDUCTORS**
*In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 63-68 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 11C

# 28 PROPELLANTS AND FUELS

Includes rocket propellants, igniters, and oxidizers; their storage and handling procedures; and aircraft fuels.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *44 Energy Production and Conversion.*

**N91-20318#** Air Force Astronautics Lab., Edwards AFB, CA.
**SOLID PROPELLANT TEMPERATURE PROFILES OBTAINED THROUGH EMBEDDED MICROTHERMOCOUPLES Final Report, Jan. - Jul. 1990**
Gregory M. Hall Oct. 1990 72 p
(AD-A229975; AL-TR-90-077) Avail: NTIS HC/MF A04 CSCL 21/9

The results are presented which were acquired during a solid propellant combustion project. Four propellants were studied: Ammonium nitrate (primarily), double base, HMX1, and HMX2. The results are presented as temperature profiles of the various propellants. These were obtained through the use of embedded thermocouples in the propellants. In addition to temperature profiles, different thermocouple sizes and lead angles, different embedment processes, and observations of the burn characteristics are all included as data. GRA

**N91-20319#** Sievers Research, Inc., Boulder, CO.
**A NEW INSTRUMENTAL TECHNIQUE FOR THE ANALYSIS OF HIGH ENERGY CONTENT FUELS Final Report, Apr. - Dec. 1986**
Ric Hutte Jul. 1990 29 p
(Contract F33615-86-C-2609)
(AD-A230130; WRDC-TR-89-2018) Avail: NTIS HC/MF A03 CSCL 21/4

This technical effort was directed at determining the feasibility of using the redox chemiluminescence detector (RCD) for the selective detection of cycloalkanes and antioxidants in jet fuels. Three catalysts (gold, palladium, and platinum) were prepared and evaluated at several reaction temperatures. The gold catalyst at 300 C produced the best selectivity for cycloalkanes (40:1 for hexane and 3:1 for nonane). However, as temperature was increased, the selectivity for cycloalkanes decreased. The palladium and platinum catalysts did not demonstrate adequate selectivity under the examined test conditions. Overall, the metal catalysts examined in this study did not exhibit sufficient selectivity to permit detection of cycloalkanes versus acyclic alkanes. The selectivity of the RCD for easily oxidized compounds (e.g., phenols) versus hexane was typically 104 to 106. GRA

**N91-20320#** Utah Univ., Salt Lake City. Dept. of Chemistry.
**PHOTOINITIATED CHAIN REACTIONS IN LOW TEMPERATURE SOLIDS Final Report, Feb. 1987 - Feb. 1990**

Charles A. Wight Aug. 1990 21 p
(Contract F04611-87-K-0023)
(AD-A230131; AL-TR-90-027) Avail: NTIS HC/MF A03 CSCL 21/9

One of the primary goals of the Air Force's High Energy Density Materials Research Program is to identify new materials which might serve the nation's needs for revolutionary (as well as evolutionary) propellant materials. The search for new metastable species is made difficult because thermodynamic instability is often accompanied by kinetic reactivity that is, higher energy materials are often the most reactive; therefore, they are the most difficult to store. An important key to success will be reducing the kinetic reactivity of a solid propellant until it is ignited. With this in mind, it is likely that any new propellant material will have to be stored as a low temperature solid, or perhaps in a low temperature solid matrix. Our research program was designed to investigate fundamental properties of solid state reactions. Fundamental aspects of chain reactions in amorphous solid films have been investigated at cryogenic temperatures. Mechanisms of reaction initiation, propagation and termination are described. Most of the experimental studies of this type have been focused on photochlorination reactions of simple hydrocarbons with molecular chlorine in the solid state, photopolymerization reactions of solid formaldehyde, and photodestruction of solid ozone and mixtures of ozone with water and chlorine. Methods have been developed for characterizing the physical properties of vapor-deposited films (van der Waals glasses) at low temperatures. Finally, a simple theory of chain reactions in pure amorphous solids and in binary amorphous solid solutions has recently been developed which accounts for most of the experimental observations made on these systems to date. GRA

**N91-20321#** Army Armament Research and Development Command, Dover, NJ. Armament Engineering Directorate.
**AN ANALYSIS OF IMPACT INITIATION OF EXPLOSIVES AND THE CURRENTLY USED THRESHOLD CRITERIA Final Report, Jan. 1989 - Feb. 1990**
Barry D. Fishburn Nov. 1990 54 p
(AD-A230187; ARAED-TR-90029) Avail: NTIS HC/MF A04 CSCL 19/1

This work ties together published experimental and theoretical results concerning the threshold condition for initiation of explosives during impact and/or penetration by projectiles or shaped charge jets. The shape of a projectile's tip, which may effect either pressure (if pointed) or duration (if rounded), has well known strong effects on the threshold velocity. A qualitative analysis is incorporated which satisfactorily relates these effects to results obtained with flat nosed rod impacts. Further, evidence is presented that even shaped charge jets display a significant nose shape effect, which adds complication to evaluating the response of explosives to jets. There is a strong, convincing evidence that for each impactor (effective) diameter, a certain threshold pressure is required for initiation. However, some (nominally) conflicting data exist and are discussed. GRA

**N91-20322#** Sandia National Labs., Albuquerque, NM.
**ADVANCED THERMALLY STABLE JET FUELS DEVELOPMENT PROGRAM ANNUAL REPORT. VOLUME 1: MODEL AND EXPERIMENT SYSTEM DEVELOPMENT Interim Report, Jun. 1989 - Jun. 1990**
Elmer Klavetter, Tim OHern, Bill Marshall, Jr., Ray Merrill, and Greg Frye Sep. 1990 81 p
(Contract FY1455-89-N-0635)
(AD-A229692; WRDC-TR-90-2079-Vol-1) Avail: NTIS HC/MF A05 CSCL 21/4

Aviation turbine fuel thermal stability is of concern because of the potential operational problems arising from the degradation of fuels when used to cool aircraft components. Within this program, investigations are proceeding to develop candidate advanced thermally stable fuels, kinetic models of fuel degradation and to measure parameters for computational fluid dynamic models to predict the degradation of fuel under various conditions. This report summarized efforts in the first year of the program to identify specific processes and parameters involved in fuel thermal degradation and to develop diagnostic instrumentation and experiment apparatus that can be used to obtain data for model development. GRA

**N91-20323#** Pennsylvania State Univ., University Park. Dept. of Materials Science and Engineering.
**ADVANCED THERMALLY STABLE JET FUELS DEVELOPMENT PROGRAM ANNUAL REPORT. VOLUME 2: COMPOSITIONAL FACTORS AFFECTING THERMAL DEGRADATION OF JET FUELS Interim Report, Jul. 1989 - Jun. 1990**
Semih Eser, Chunshan Song, Harold Schobert, Patrick Hatcher, and Ronald Copenhaver Sep. 1990 98 p
(Contract FY1455-89-N-0635)
(AD-A229693; WRDC-TR-90-2079-Vol-2) Avail: NTIS HC/MF A05 CSCL 21/4

Model hydrocarbon compounds and jet fuels derived from both petroleum and coal liquids were thermally stressed in microautoclave reactors at temperatures of 350 to 500 C. Regardless of starting material, alkylated benzenes, alkylated naphthalenes, biphenyls, and complex polycyclic aromatics are formed by this thermal stressing. The concentration of these intermediates depends on the starting material and the experimental conditions. The formation of solids is directly related to high concentrations of alkylbenzenes and polycyclic aromatics in the liquid phase. Solid products consist primarily of large polycyclic aromatics with varying aliphatic substitution and their composition depends on the compound and the thermal conditions. Analysis of the solids showed anisotropic structures consistent with pseudo-nematic liquid crystalline mesophase. From these experiments a preliminary ordering of compound stability based on structure has been established. GRA

**N91-20324*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**SELF-PRESSURIZATION OF A FLIGHTWEIGHT LIQUID HYDROGEN STORAGE TANK SUBJECTED TO LOW HEAT FLUX**
M. M. Hasan, C. S. Lin (Analex Corp., Fairview Park, OH.), and N. T. VanDresar 1991 8 p Proposed for presentation at the 1991 ASME/AIChE National Heat Transfer Conference, Minneapolis, MN, 28-31 Jul. 1991
(Contract NAS3-25776)
(NASA-TM-103804; E-6095; NAS 1.15:103804) Avail: NTIS HC/MF A02 CSCL 21I

Results are presented for an experimental investigation of self-pressurization and thermal stratification of a 4.89 cu m liquid hydrogen (LH2) storage tank subjected to low heat flux (0.35, 2.0, and 3.5 W/sq m) under normal gravity conditions. Tests were performed at fill levels of 83 to 84 percent (by volume). The LH2 tank was representative of future spacecraft tankage, having a low mass-to-volume ratio and high performance multilayer thermal insulation. Results show that the pressure rise rate and thermal stratification increase with increasing heat flux. At the lowest heat flux, the pressure rise rate is comparable to the homogenous rate, while at the highest heat flux, the rate is more than three times the homogeneous rate. It was found that initial conditions have a significant impact on the initial pressure rise rate. The quasi-steady pressure rise rates are nearly independent of the initial condition after an initial transient period has passed.
Author

**N91-20325#** Louisiana State Univ., Baton Rouge. Dept. of Chemical Engineering.
**THE EFFECTS OF FUEL ADDITIVES ON SOOT FORMATION Final Report, Feb. 1986 - Nov. 1988**
Arthur M. Sterling, Gregory B. Arbour, and Nathan P. Adams, III Mar. 1990 114 p
(Contract F08635-86-K-0042)
(AD-A230633; ESL-TR-89-14) Avail: NTIS HC/MF A06 CSCL 21/4

The effect of an iron additive on soot formation during the

pyrolysis and oxidation of benzene was studied in a conventional, 7.6-cm i.d. shock tube. Iron pentacarbonyl, Fe(CO)(5), as a surrogate for ferrocene, was used as the additive. As a control, carbon monoxide (CO) was also considered an additive. Measurements were carried out at two pressure levels (2-3 atm. and 5-7 atm.) over a temperature range from 1600 to 2400 K. No direct influence of iron could be demonstrated, although a weak effect would have been obscured by a surprisingly strong enhancement of sooting by CO during low-pressure pyrolysis and high-pressure oxidation. An indirect effect of iron was to reduce or eliminate the enhancement of soot yield by CO. GRA

**N91-20326#** Cranfield Inst. of Tech., Bedford (England). Coll. of Aeronautics.
**INTERNAL BALLISTICS USING TWO DIFFERENT PROPELLANT GRAIN FORM FUNCTIONS**
J. Pike Mar. 1990 17 p
(Cranfield-Aero-9003; ISBN-1-871564-04-2; ETN-91-99013)
Avail: NTIS HC/MF A03; Cranfield Inst. of Technology, Coll. of Aeronautics, Cranfield, Bedford MK43 0AL, England, HC 8 sterling pounds

The combustion of multitube propellant grains is represented either by the Corner form function or an exact parallel burning layer expression. The exact expression predicts significantly different burning characteristics near the end of the burn to that of the Corner form function. When used in a typical gun firing calculation, the exact expression gives pressure histories which are closer to the experimental results. It also gives longer burn times and a reduction in the nozzle velocity of the projectile. The desirability of using the exact form function more generally in computational internal ballistics codes to improve the accuracy is stated and a FORTRAN subroutine suitable for 7 tube grains is supplied. ESA

# 29 MATERIALS PROCESSING

Includes space-based development of products and processes for commercial applications.

For biological materials see *55 Space Biology*.

No abstracts in this category.

# 31 ENGINEERING (GENERAL)

Includes vacuum technology; control engineering; display engineering; cryogenics; and fire prevention.

**N91-20327*#** Alabama Cryogenic Engineering, Inc., Huntsville.
**HELIUM 3/HELIUM 4 DILUTION CRYOCOOLER FOR SPACE**
**Final Report, 12 Jul. 1989 - 12 Feb. 1991**
John B. Hendricks and Michael L. Dingus 11 Mar. 1991 116 p
(Contract NAS8-37437)
(NASA-CR-184140; NAS 1.26:184140) Avail: NTIS HC/MF A06 CSCL 13B

Prototype dilution cryocoolers based on dilution refrigeration and adiabatic demagnetization refrigeration (ADR) cycles were designed, constructed, and tested. Although devices the devices did not operate as fully functional dilution cryocoolers, important information was gathered. The porous metal phase separator was demonstrated to operate in the -1-g configuration; this phase separation is the critical element in the He-3 circulation dilution cryocooler. Improvements in instrumentation needed for additional tests and development were identified. Author

**N91-20328#** Air War Coll., Maxwell AFB, AL.
**SOFTWARE METRICS USEFUL TOOLS OR WASTED MEASUREMENTS**
Robert A. Austin and John M. Case, Jr. May 1990 73 p
(AD-A229951) Avail: NTIS HC/MF A04 CSCL 12/5

A large number of Air Force programs require significant software development during implementation. Unfortunately, the software almost always takes longer than anticipated and requires extensive manpower to remove latent defects from the delivered products. Industry and academia are doing a great deal of work in the developing field of software production and quality metrics (tools designed to help estimate project size and assess software quality); thus, alleviating this industry-wide problem. This study examines the current state of these tools to see if they provide useful measures which can improve the software component of Air Force programs or if the effort used to implement these metrics represents wasted manpower. The study concludes with an assessment that the tools provide valuable data which, when properly applied, can help software managers set achievable schedules for quality software products which can be completed on time and require significantly less software maintenance manpower. Author (GRA)

**N91-20329*#** Carnegie-Mellon Univ., Pittsburgh, PA. Robotics Inst.
**INTEGRATED SYSTEM FOR SINGLE LEG WALKING**
Reid Simmons, Eric Krotkov, and Gerry Roston Jul. 1990 58 p
(Grant NAGw-1175)
(NASA-CR-188072; NAS 1.26:188072; AD-A230115;
CMU-RI-TR-90-15) Avail: NTIS HC/MF A04 CSCL 17/7

The Carnegie Mellon University Planetary Rover project is developing a six-legged walking robot capable of autonomously navigating, exploring, and acquiring samples in rugged, unknown environments. This report describes an integrated software system capable of navigating a single leg of the robot over rugged terrain. The leg, based on an early design of the Ambler Planetary Rover, is suspended below a carriage that slides along rails. To walk, the system creates an elevation map of the terrain from laser scanner images, plans an appropriate foothold based on terrain and geometric constraints, weaves the leg through the terrain to position it above the foothold, contacts the terrain with the foot, and applies force enough to advance the carriage along the rails. Walking both forward and backward, the system has traversed hundreds of meters of rugged terrain including obstacles too tall to step over, trenches too deep to step in, closely spaced obstacles, and sand hills. The implemented system consists of a number of task-specific processes (two for planning, two for perception, one for real-time control) and a central control process that directs the flow of communication between processes. GRA

**N91-20330*#** Carnegie-Mellon Univ., Pittsburgh, PA. Robotics Inst.
**INTEGRATED MOBILE ROBOT CONTROL**
Omead Amidi May 1990 33 p
(Grants NAGw-1175; NSF DCR-86-04199)
(NASA-CR-188073; NAS 1.26:188073; AD-A230117;
CMU-RI-TR-90-17) Avail: NTIS HC/MF A03 CSCL 17/7

Real time mobile robot controllers have usually been designed with an emphasis on control theory ignoring the importance of system integration. This report demonstrates that useful mobile robots require a real-time controller with a wide range of capabilities in addition to control theory. These capabilities include: position estimation, mapping and tracking of paths, human interfaces, fast communication, multiple client support, and monitoring vehicle status for safety and debugging. An architectural framework supporting these capabilities has been designed and implemented. Using this framework, individual modules such as a position estimator, a path tracker, a mapper, network serves and other crucial elements have been successfully integrated into a controller of the Navlab autonomous vehicle. Issues regarding the use of an Inertial Navigation System for position estimation are discussed and the positioning data is compared to dead reckoning techniques. Three path tracking strategies: pure pursuit, quintic polynomial fit, and control theory approach are analyzed and compared. In addition the operation of a smooth velocity for the Navlab is discussed. The context of the research, the architecture, its implementation, and other performance results from experiments are discussed. GRA

**N91-20331*#** Carnegie-Mellon Univ., Pittsburgh, PA. Robotics Inst.
**CONCURRENT PLANNING AND EXECUTION FOR A WALKING ROBOT**
Reid Simmons Jul. 1990 19 p
(Grant NAGw-1175)
(NASA-CR-188074; NAS 1.26:188074; AD-A230118; CMU-RI-TR-90-16) Avail: NTIS HC/MF A03 CSCL 12/9

The Planetary Rover project is developing the Ambler, a novel legged robot, and an autonomous software system for walking the Ambler over rough terrain. As part of the project, we have developed a system that integrates perception, planning, and real-time control to navigate a single leg of the robot through complex obstacle courses. The system is integrated using the Task Control Architecture (TCA), a general-purpose set of utilities for building and controlling distributed mobile robot systems. The walking system, as originally implemented, utilized a sequential sense-plan-act control cycle. This report describes efforts to improve the performance of the system by concurrently planning and executing steps. Concurrency was achieved by modifying the existing sequential system to utilize TCA features such as resource management, monitors, temporal constraints, and hierarchical task trees. Performance was increased in excess of 30 percent with only a relatively modest effort to convert and test the system. The results lend support to the utility of using TCA to develop complex mobile robot systems. GRA

**N91-20332#** Air Force Systems Command Liason Office, Ottawa (Ontario).
**GUIDE TO CANADIAN AEROSPACE-RELATED INDUSTRIES Biennial Report, Sep. 1988 - Aug. 1990**
Donald J. Pearson, Thomas H. Burleson, and George M. Mullen Aug. 1990 161 p
(AD-A230151; AFSC-TR-003-90; ARDSG-CIRC-70-1) Avail: NTIS HC/MF A08 CSCL 05/1

This guide is a contracting source list of Canadian aerospace related industries to be used by USAF and USA procurement offices, program managers, project engineers, and scientists. It provides company profiles, a company keyword index, and contact points for each company. GRA

**N91-20333#** New Mexico Univ., Albuquerque. Engineering Research Inst.
**NEXT-GENERATION FIRE EXTINGUISHING AGENT, PHASE 3 Final Report, Dec. 1987 - Aug. 1988**
Robert E. Tapscott, Joanne P. Moore, Michael E. Lee, Jimmy D. Watson, and E. T. Morehouse Apr. 1990 45 p
(Contract F29601-84-C-0080)
(AD-A230619; NMERI-WA3-79-(3.21); AFESC/ESL-TR-87-03) Avail: NTIS HC/MF A03 CSCL 13/12

This project was established to originate concepts for next-generation fire extinguishing agents. In Phase 3, an effort to develop a substitute agent to replace Halon 1211 in Air Force firefighter training was initiated. Laboratory scale investigations of flame extinguishment by chlorofluorcarbons (CFCs) and hydrochlorofluorocarbons (HCSCs) were performed. Laboratory studies of physical properties of CFC blends were also carried out. GRA

# 32 COMMUNICATIONS AND RADAR

Includes radar; land and global communications; communications theory; and optical communications.

For related information see also *04 Aircraft Communications and Navigation* and *17 Space Communications, Spacecraft Communications, Command and Tracking.* For search and rescue see *03 Air Transportation and Safety,* and *16 Space Transportation.*

**N91-20334** Department of the Navy, Washington, DC.
**PLANAR END-FIRE ARRAY Patent**
William J. Mueller, inventor (to Navy) 23 Oct. 1990 8 p Filed 22 Jan. 1969
(AD-D014726; US-Patent-4,965,776; US-Patent-Appl-SN-795770; US-Patent-Class-367-126) Avail: US Patent and Trademark Office CSCL 17/1

A planar end fire acoustic transducer array is composed of a planar matrix of individual elements. In order to give this array an end fire characteristic, predetermined elements are provided with outputs which are phase-inverted with respect to the outputs of the other elements of the array. The sum of the gains of these predetermined elements are made equal to the sum of the gains of the other elements. GRA

**N91-20335*#** Akron Univ., OH. Dept. of Electrical Engineering.
**DETECTION OF REFLECTOR SURFACE FROM NEAR FIELD PHASE MEASUREMENTS Final Report**
Nathan Ida 27 Feb. 1991 43 p
(Contract NCC3-146)
(NASA-CR-187948; NAS 1.26:187948) Avail: NTIS HC/MF A03 CSCL 20N

The deviation of a reflector antenna surface from a perfect parabolic shape causes degradation of the performance of the antenna. The problem of determining the shape of the reflector surface in a reflector antenna using near field phase measurements is not a new one. A recent issue of the IEEE tansactions on Antennas and Propagation (June 1988) contained numerous descriptions of the use of these measurements: holographic reconstruction or inverse Fourier transform. Holographic reconstruction makes use of measurement of the far field of the reflector and then applies the Fourier transform relationship between the far field and the current distribution on the reflector surface. Inverse Fourier transformation uses the phase measurements to determine the far field pattern using the method of Kerns. After the far field pattern is established, an inverse Fourier transform is used to determine the phases in a plane between the reflector surface and the plane in which the near field measurements were taken. These calculations are time consuming since they involve a relatively large number of operations. A much faster method can be used to determine the position of the reflector. This method makes use of simple geometric optics to determine the path length of the ray from the feed to the reflector and from the reflector to the measurement point. For small physical objects and low frequencies, diffraction effects have a major effect on the error, and the algorithm provides incorrect results. It is believed that the effect is less noticeable for large distortions such as antenna warping, and more noticeable for small, localized distortions such as bumps and depressions such as might be caused by impact damage. Author

**N91-20336#** National Oceanic and Atmospheric Administration, Boulder, CO. Wave Propagation Lab.
**DUAL-FREQUENCY RADAR: BASIC THEORY AND SURFACE CURRENT MAPPING PERFORMANCE FOR LAND-BASED SYSTEMS**
A. Jay Palmer (Colorado Univ., Boulder.) Oct. 1990 33 p
(PB91-121251; NOAA-TM-ERL-WPL-186) Avail: NTIS HC/MF A03 CSCL 17I

The essential theoretical aspects of dual-frequency radar sensing of ocean surface currents are reviewed. The basic single carrier frequency technique as well as the multiple carrier frequency technique used to improve the signal-to-noise ratio are included. A calculation of the dependence of the signal-to-noise ratio on a finite time separation between the transmitted radar signals and calculations of the achievable surface-current resolution for land-based systems are presented. Scaling relationships and resolution contours are plotted, which will help in the design of an optimal current mapping system. A brief discussion is presented of two new dual-frequency radar concepts: bistatic dual-frequency radar and dual-frequency sodar. GRA

**N91-20337#** Federal Aviation Administration, Atlantic City, NJ.
**DATA LINK TEST AND ANALYSIS SYSTEM/TCAS MONITOR USER'S GUIDE**

John VanDongen and Leo Wapelhorst Feb. 1991 53 p
(Contract FAA-T2001-F)
(DOT/FAA/CT-TN90/62) Avail: NTIS HC/MF A04

This document is a user's guide for the Data Link Test and Analysis System (DATAS) Traffic Alert and Collision Avoidance System (TCAS) monitor. It provides a brief overall hardware description of DATAS configured as a TCAS monitor, and the applications software. Author

**N91-20338#** Electronics Research Lab., Adelaide (Australia).
**TROPOSPHERIC PROPAGATION MODELLING WITH THE PARABOLIC EQUATION**
Patricia L. Slingsby Sep. 1990 53 p
(AD-A229853; ERL-0531-RR; DODA-AR-006-452) Avail: NTIS HC/MF A04 CSCL 20/14

The parabolic equation is a full-wave approximation to the Helmholtz wave equation that, unlike existing ray tracing and coupled mode techniques, readily accommodates two-dimensionally inhomogeneous atmospheres. The implementation of a split-step Fourier transform solution to the parabolic equation is discussed, and examples of coverage diagrams calculated by this method are included. GRA

**N91-20339#** Los Alamos National Lab., NM. Mechanical and Electronic Engineering Div.
**ULTRA-WIDEBAND RADAR: RESEARCH AND DEVELOPMENT CONSIDERATIONS**
5 Jun. 1989 141 p Sponsored by Naval Ocean Systems Center, San Diego, CA
(AD-A229882; LA-UR-89-1420) Avail: NTIS HC/MF A07 CSCL 17/9

An initial investigation into the technology of impulse radar is provided. The principal purpose is to provide a road map for exploratory development by defining critical technology issues for a research investment strategy. There are urgent requirements for improving radar capability for target identification or noncooperative target recognition (NCTR). Progress in NCTR was primarily in information processing, with few technological advances in the sensor domain. Impulse radar provides new and revolutionary ideas which can offer new capabilities for active surveillance. These capabilities are discussed along with issues that must be resolved before system development is undertaken. GRA

**N91-20340#** Communications Research Centre, Ottawa (Ontario).
**DIVERSITY PERFORMANCE IN FREQUENCY-HOPPED 8-ARY SIGNALS-IMPLEMENTATION AND MEASUREMENTS**
P. Tardif and E. B. Felstead Jun. 1990 49 p
(AD-A229986; CRC-1432) Avail: NTIS HC/MF A03 CSCL 17/4

A microprocessor based signal processor was built and tested that is capable of performing the diversity combining needed to reduce the error rate of 8-ary noncoherent FSK signals demodulated onboard a satellite. Two combining techniques were implemented and tested: hard decision majority vote (HDMV) and normalized envelope detection (NED). Measurements of bit error rate performance of these two techniques in the presence of system noise plus either partial-band noise (PBN) or multiple tone (MT) jamming were made for levels of diversity, L, from 1 to 32. The signal-to-jammer ratio (SJR) levels used were so low that worst case jamming was always with the full band jammed. Results showed that HDMV combining could give error correction for PBN jamming for a SJR as low as O dB but gave no correction for MT jamming when the SJR was less than 10 dB even for L as high as 32. NED combining handled PBN jamming better than the HDMV and performed very well against MT jamming even at a SJR as low as odB. Results show for the low SJR regime considered, that NED combining is clearly the error correction method of choice over HDMV combining and even over low rate convolutional coding. GRA

**N91-20341#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
**LES-8/9 SPECTRUM-SURVEY TECHNIQUES**
Warren K. Hutchinson, W. W. Ward, and H. H. Hoover 5 Oct. 1990 29 p
(Contract F19628-90-C-0002)
(AD-A230092; TR-888; ESD-TR-90-092) Avail: NTIS HC/MF A03 CSCL 20/15

Techniques for surveying the electromagnetic spectrum using communications satellites as sensors are discussed. The techniques presented are based on the use of tunable (by ground command) frequency synthesizers carried on Lincoln Experimental Satellites 8 and 9 (LES-8/9). The frequency synthesizers are used for first-downconversion local oscillator in the satellite uplink receiver. Repetitive commanding of these synthesizers combined with on-board selectable filter bandwidths, signal power detectors, and a high telemetry data rate are shown to constitute an effective spectrum analyzer. Interpretation and presentation of collected data are also discussed. GRA

**N91-20342#** BBN Systems and Technologies Corp., Cambridge, MA.
**IMPROVEMENTS IN THE BYBLOS CONTINUOUS SPEECH RECOGNITION SYSTEM Final Report, 18 Jan. 1988 - 30 Sep. 1990**
R. Schwartz, S. Austin, C. Barry, F. Kubala, and J. Makhoul Nov. 1990 57 p
(Contract N00014-85-C-0279)
(AD-A230126; BBN-7528) Avail: NTIS HC/MF A04 CSCL 25/4

The objective of this research was to develop accurate mathematical models of speech sounds for the purpose of large-vocabulary continuous speech recognition. The research focussed on three areas: developing better speech models to improve recognition accuracy; exploring new techniques for speaker-independent training; and developing speaker adaptation techniques that allow system use with a minimum of training. The work was performed within the BBN BYBLOS speech recognition system, which is based on the use of phonetic hidden Markov models. As a result of several model improvements, we have succeeded in decreasing the word rate by a factor of four for speaker-dependent and speaker-independent recognition. In speaker-independent recognition, we developed a new training paradigm in which we record speech from only a dozen speakers instead of the traditional approach of recording more than a hundred speakers. The same approach has been shown to be useful for effective speaker adaptation with only two minutes of speech training. GRA

**N91-20343#** Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
**SITE CHARACTERIZATION FOR RADAR EXPERIMENTS Final Report**
Katherine S. Long Aug. 1990 179 p Prepared in cooperation with Massachusetts Inst. of Tech., Lexington
(AD-A230150; WES/TR/EL-90-8) Avail: NTIS HC/MF A09 CSCL 17/9

This report describes a field characterization effort designed to furnish the data necessary to support the interpretation of products obtained by an airborne radar imaging mission. Three different types of small mines were precisely located relative to established benchmarks. The surface topography, surface composition, vegetation, and micrometeorology were also characterized. This was executed with sufficient precision so that modelers might characterize the clutter surrounding the objects (targets) imaged. Three 38- by 44-m plots were characterized by recording elevation differences as small as 1 cm for each of the three plots and 0.1 cm for three 1-m subplots within each of the larger plots. Roughness measurements at a scale likely to influence the radar returns were calculated. Soil composition was determined, and the locations of samples are shown in reference to plot coordinates. Principal soil types were sampled for moisture content, specific gravity, and grain size distribution; dielectric measurements

of permittivity of the three plots. Physical and floristic attributes of the vegetation communities present were determined using both field and laboratory methods. GRA

**N91-20344#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
**A DESIGN FOR AN ELECTRO-OPTIC IMPLEMENTATION OF A WIDEBAND NULLING SYSTEM**
Alexander Sonnenschein and Warren K. Hutchinson 1 Nov. 1990 32 p
(Contract F19628-90-C-0002)
(AD-A230152; TR-887; ESD-TR-90-108) Avail: NTIS HC/MF A03 CSCL 20/6

A wideband nulling antenna system is difficult to build with RF and IF microwave components. The main obstacle to achieving deep, wideband (greater than 1 GHz) nulls is the necessity for extremely accurate channel tracking over the large percentage bandwidth by many components in the receiver chain. Inadequate channel tracking between any two parallel components in the chain could severely degrade the overall nulling performance. Recent advances in optical technology hold the realistic prospect of alleviating much of the channel tracking problem, as well as potentially providing the secondary benefits of reduced weight and volume. Once the RF signal is converted to an optical frequency, the minute percentage bandwidth occupied by the signal should make channel tracking the subsequent optical components a relatively easy task. This report proposes an electro-optical implementation of a wideband nulling antenna system. It is shown that all the required components of an optical nuller are within the current state of art. The chosen electro-optical devices have no inherent limitation that will prevent their being used in a direct RF-to-optical implementation at frequencies up to and including the EHF band. Author (GRA)

**N91-20345#** Rockwell International Corp., Thousand Oaks, CA. Science Center.
**SPREAD SPECTRUM RANDOM ACCESS SCHEMES Final Report, 15 Sep. 1987 - 29 Nov. 1990**
A. R. Sastry, L. P. Clare, and J. E. Baker 17 Dec. 1990 106 p
(Contract N00014-87-C-0845)
(AD-A230303; SC5524.FR) Avail: NTIS HC/MF A06 CSCL 25/2

Detailed investigations have been carried out on frequency-hopped spread spectrum random access (SSRA) schemes in the presence of jamming, including control procedures for stable operation. Simulations also were carried out to verify and supplement the analytical results. It is shown that, unlike unspread systems, performance of a frequency-hopped packet communication network does not depend heavily on the burstiness of the user traffic or on whether slotted operation is used. Partial band and pulse jamming effects are modeled, and the possibility of successful reception of spreading code symbols with partial overlap is represented. Static and dynamic control policies are considered for slotted ALOHA-SSRA schemes, with emphasis on the effects of the retransmission control policy. Performance of dynamic control is shown to be very robust in that it provides high throughput over wide ranges of arrival rates, unlike static control, which is highly sensitive to packet generation process and the chosen retransmission probability. GRA

**N91-20346#** Naval Postgraduate School, Monterey, CA.
**AN ANALYSIS OF FOUR ERROR DETECTION AND CORRECTION SCHEMES FOR THE PROPOSED FEDERAL STANDARD 1024 (LAND MOBILE RADIO) M.S. Thesis**
Carol A. Lohrmann Mar. 1990 141 p
(AD-A230308) Avail: NTIS HC/MF A07 CSCL 12/5

Interoperability of commercial Land Mobile Radios (LMR) and the military's tactical LMR is highly desirable if the U.S. government is to respond effectively in a national emergency or in a joint military operation. This ability to talk securely and immediately across agency and military service boundaries is often overlooked. One way to ensure interoperability is to develop and promote Federal communication standards (FS). This thesis surveys one area of the proposed FS 1024 for LMRs; namely, the error detection and correction (EDAC) of the message indicator (MI) bits used for cryptographic synchronization. Several EDAC codes are examined (Hamming, Quadratic Residue, hard decision Golay and soft decision Golay), tested on three FORTRAN programmed channel simulations (INMARSAT, Gaussian and constant burst width), compared and analyzed (based on bit error rates and percent of error-free super-frame runs) so that a best code can be recommended. Out of the four codes under study, the soft decision Golay code (24,12) is evaluated to be the best. This finding is based on the code's ability to detect and correct errors as well as the relative ease of implementation of the algorithm. GRA

**N91-20347#** Delta Information Systems, Inc., Horsham, PA.
**STANDARDIZATION OF FREEZE FRAME TV CODECS Final Report**
Jun. 1990 91 p
(Contract DCA100-87-C-0078)
(AD-A230322; NCS-TIB-90-10) Avail: NTIS HC/MF A05 CSCL 25/5

The purpose of this report is to recommend a protocol and a compression technique to be considered as the standard for freeze frame teleconferencing equipment. The recommendations are based on: (1) analysis of freeze frame teleconferencing equipments presently in use; (2) consideration of previous and presently on-going standardization efforts in related areas by respected technical organizations; and (3) the unique requirements teleconferencing places on freeze frame technology; i.e., compression, transmission, resolution, gray scale, storage, and display. Freeze frame technology is a technique by means of which images normally requiring a wide band communication circuit for transmission can be transmitted over narrow band circuits. This is accomplished by selecting individual frames or fields from a television signal train for transmission. The concept of motion is, of course, lost, but the information content of a frame is conveyed in its entirety (up to the specifications of the codec). The trade-off is channel bandwidth versus transmission time. GRA

**N91-20348#** Ohio State Univ., Columbus. Electroscience Lab.
**UNIFORM THEORY OF DIFFRACTION (UTD) SCATTERING FROM STRUCTURES, INCLUDING HIGHER ORDER TERMS. VOLUME 2: EDGE WAVE EDGE AND VERTEX DIFFRACTION Final Report, Apr. 1986 - Dec. 1989**
Leonidas P. Ivrissimtzis and Ronald J. Marhefka Nov. 1990 106 p
(Contract F33615-86-K-1023)
(AD-A230339; Rept-718295-9-Vol-2; WRDC-TR-90-9003-Vol-2)
Avail: NTIS HC/MF A06 CSCL 20/14

The diffraction of an edge wave by the vertex and the edges of a semi-infinite wedge (a trihedron) is studied. The edge wave is produced by an infinitesimal electric dipole source located in close vicinity of one of the edges of the trihedron and sufficiently far from the vertex. The radiation integral of the currents that would flow over an infinite wedge, which is then truncated, is evaluated asymptotically, yielding an endpoint effect. The final result is improved by introducing a fringe current component induced by the terminating edges, and exhibits fairly good agreement with moment method computations and measured data. The field diffracted by a corner and propagating along the edge of a flat plate structure can be obtained via reciprocity. The edge wave corner diffraction coefficient thus derived may be utilized for the calculation of corner-to-corner and corner-to-edge diffraction mechanisms. GRA

**N91-20349#** Ohio State Univ., Columbus. Electroscience Lab.
**UNIFORM THEORY OF DIFFRACTION (UTD) SCATTERING FROM STRUCTURES, INCLUDING HIGHER ORDER TERMS. VOLUME 3: TECHNICAL OVERVIEW Final Report, Apr. 1986 - Dec. 1989**
Timothy J. Brinkley, Leonidas P. Ivrissimtzis, and Ronald J. Marhefka Nov. 1990 54 p
(Contract F33615-86-K-1023)

(AD-A230340; Rept-718295-12-Vol-3; WRDC-TR-90-9003-Vol-3)
Avail: NTIS HC/MF A04 CSCL 20/14

In this volume, a summary of the basic formulation associated with higher order terms in the theory associated with Uniform Theory of Diffraction (UTD) scattering from structures is presented. Theoretical solutions for bistatic first order and higher order UTD terms, which provide an accurate and efficient means of calculating high frequency scattering from large complex geometries, are discussed. These techniques are eventually incorporated into the user-oriented computer code referred to as the RCS Basic Scattering Code (BSC). GRA

**N91-20350#** Ohio State Univ., Columbus. Electroscience Lab.
**UNIFORM THEORY OF DIFFRACTION (UTD) SCATTERING FROM STRUCTURES, INCLUDING HIGHER ORDER TERMS. VOLUME 6: OVERVIEW OF ACCOMPLISHMENTS Final Report, Apr. 1986 - Dec. 1989**
Timothy J. Brinkley, Leonidas P. Ivrissimtzis, and Ronald J. Marhefka Nov. 1990 117 p
(Contract F33615-86-K-1023)
(AD-A230341; Rept-718295-16-Vol-6; WRDC-TR-90-9003-Vol-6)
Avail: NTIS HC/MF A06 CSCL 20/14

This volume summarizes the effort accomplished. Theoretical solutions for bistatic first order and higher order Uniform Theory of Diffraction (UTD) terms provide an accurate and efficient means to calculate high frequency scattering from large complex geometries. These techniques have been incorporated into a user-oriented computer code referred to as the Radar Cross Section (RCS) Basic Scattering Code (BSC) (Version 2.0). GRA

**N91-20351#** Massachusetts Inst. of Tech., Cambridge. Lincoln Lab.
**GEOLOCATION OF FREQUENCY-HOPPING TRANSMITTERS VIA SATELLITE**
Alexander Sonnenschein and Warren K. Hutchinson 6 Nov. 1990 32 p
(Contract F19628-90-C-0002)
(AD-A230373; TR-900; ESD-TR-90-115) Avail: NTIS HC/MF A03 CSCL 17/7

A satellite-communications terminal geolocation is analyzed by satellite interception, whereby a number of spaceborne interceptors transpond the frequency band of interest to a terrestrial location for processing. The general formulas for the interception accuracy are summarized, and a strawman interceptor system is proposed. Interception regions for prototypical terminals and satellites are calculated and the results are presented parametrically as a function of uplink SNR. The optimum angular separation of the interceptor satellites is found, and the effect of nonoptimal separation is discussed. The practical limitations involved in implementing this geolocation system are also discussed. GRA

**N91-20352#** Booz-Allen and Hamilton, Inc., Bethesda, MD.
**MULTIPROTOCOL GATEWAY CAPABILITIES DEMONSTRATION REPORT Final Report**
9 Apr. 1990 48 p
(Contract DCA100-87-C-0063)
(AD-A230399; NCS-TIB-90-11) Avail: NTIS HC/MF A03 CSCL 12/7

The National Communications System is working to promote standards within the data communication and telecommunication fields to increase the interoperability of diverse communication systems. These interoperability efforts improve the NS/EP communication capabilities of the nation by providing additional interconnectivity among Federal telecommunication assets. One such effort is determining the feasibility of using the excess transmission capacity of the Integrated Services Digital Network (ISDN) out-of-band signaling channels to reconstitute disrupted networks. Present telecommunication networks use one of many different protocol suites to interconnect their services. Networks employing different protocols cannot communicate with one another because the diverse protocols are incompatible. To address the protocol incompatibility issue, we recommend developing mechanisms, such as gateways that provide protocol conversions, to interconnect networks using diverse protocols. GRA

**N91-20353#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**FRACTAL GEOMETRY SEGMENTATION OF HIGH RESOLUTION POLARIMETRIC SYNTHETIC APERTURE RADAR DATA M.S. Thesis**
Joseph L. Brickey Dec. 1990 117 p
(AD-A230428; AFIT/GE/ENG/90D-06) Avail: NTIS HC/MF A06 CSCL 17/9

This thesis investigated the potential of fractal dimension estimation for segmenting high resolution polarimetric synthetic aperture radar. The data used during this research were collected with the Advanced Detection Technology Sensor (ADTS) developed by Massachusetts Institute of Technology Lincoln Laboratory with Defense Advanced Research Projects Agency funding. ADTS is a fully polarimetric calibrated 35 GHz SAR with one foot impulse response. A method of applying the correlation dimension algorithm developed by Grassberger and Procaccia for estimating the dimension of time series data was implemented to estimate the correlation dimension of polarimetric SAR data. A threshold sensitivity study was performed to determine which combination of polarizations used to calculate the correlation dimension resulted in most accurately segmented image. Correlation dimension estimates were shown to be valid and robust features for segmenting ADTS imagery into culture, tree, field, and shadow regions. Simple thresholding and median filtering of correlation dimension estimates calculated from non-overlapping windows of ADTS imagery produced segmented imagery that was consistently over 90 percent accurate when using all four linear polarizations. An approach was implemented for automatically distinguishing between different classes of naturally occurring regions within the SAR image using correlation dimension estimates as input features to artificial neural networks. GRA

**N91-20354#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**THE RADAR RANGE EQUATION FOR THE DETECTION OF STEADY TARGETS IN WEIBULL CLUTTER M.S. Thesis**
Leon C. Rountree Dec. 1990 79 p
(AD-A230441; AFIT/GE/ENG/90D-53) Avail: NTIS HC/MF A05 CSCL 17/9

In this thesis, the detection characteristics of a steady target immersed in radar clutter characterized by returns statistically modeled according to a Weibull probability density function are developed. A detector model is developed by modifying an envelope detection scheme used to detect deterministic signals in Gaussian noise. By examining the statistics of the detector output under alternate hypotheses, an expression for the probability of detection (P sub d) is developed in terms of the probability of false alarm (P sub fa), the signal-to-clutter ratio (SCR), and the Weibull skewness parameter (b), which is a function of the type of terrain causing the clutter. This expression is used in conjunction with a form of the radar range equation for area clutter to describe the relationship between P sub d, P sub fa, SCR, b, and the radar detection range. This relationship involves Marcum's Q function and an algorithm is presented which evaluates this function. The algorithm is a series approximation, also presented as a recursive relationship, that can be computed to a desired precision. Plots of P sub d versus SCR and P sub d versus range are developed for various values of P sub fa and b. The plots provide a means of evaluating the detector performance and predicting the radar detection range for several values of b; thus for several types of terrain. GRA

**N91-20355#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**IMPROVING RELIABILITY IN A STOCHASTIC COMMUNICATION NETWORK M.S. Thesis**
William L. Gaught Dec. 1990 316 p
(AD-A230442; AFIT/GSO/ENS/90D-10) Avail: NTIS HC/MF A14 CSCL 12/7

This research investigated the behavior of increasing the reliability of components in stochastic communication networks. A stochastic communication network is one in which the components, links and nodes, are not 100 percent reliable. In addition to the reliability value, each component also has a capacity value that limits the flow through the component. The throughput in a stochastic communication network can be improved by increasing the capacity or the reliability of the individual components. A set of linear and nonlinear models was developed to determine the best investment strategy for increasing the reliability of individual components. Once the models were developed, an experiment was designed to compare the output of the models to another set of existing models that calculated the best investment strategy for increasing the capacity of individual components. The experiment employed a Prolog program to: enumerate the paths, compute the reliability of each path, and formulate the linear and nonlinear models for direct input into mathematical programming packages. In addition, the linear models were reformulated as networks with side constraints and solved using a network flow package. The models and methodology are general and could easily be modified. GRA

**N91-20356#** Defence Research Establishment, Ottawa (Ontario).
**A PROPOSED METHOD OF FSK GENERATION AND DEMODULATION FOR THE DREO RADIO TEST BED**
Andrew H. Mudry Mar. 1990 24 p
(AD-A229660; DREO-TN-90-13) Avail: NTIS HC/MF A03
CSCL 25/2

A Radio Test Bed (RTB) is currently being developed for the Defence Research Establishment Ottawa (DREO) under contract. The test bed is to serve as a powerful general purpose laboratory instrument for the generation and demodulation of non-exotic communications signals found in the tactical environment. The system will interface with the DREO Communications Jamming Simulator to allowing jamming studies to be performed on various communications signals. The system will have the capability of generating and demodulating the following signals: AM, FM, USB, and LSB. A method has been devised to incorporate the generation and demodulation of data modulated Frequency Shift Keyed (FSK) signals into the FTB. The modulation technique involves using a baseband data signal to directly frequency modulate an RF carrier. Demodulation is achieved by using the FM demodulator of the RTB. Some signal conditioning is required, but the FSK generation and demodulation scheme has the capability of being easily and inexpensively implemented in the RTB while it is still under construction. The proposed method has been tested at DREO excellent results. GRA

**N91-20357#** Naval Ocean Systems Center, San Diego, CA.
**SPECIFICATION FOR A SURFACE-SEARCH RADAR-DETECTION-RANGE MODEL**
Claude P. Hattan Sep. 1990 70 p
(AD-A229711; NOSC-TD-1930) Avail: NTIS HC/MF A04
CSCL 17/9

A model that predicts surface-search radar detection range versus a variety of combatants has been developed at the Naval Ocean Systems Center. This model uses a simplified ship radar cross section (RCS) model and the U.S. Navy Oceanographic and Atmospheric Mission Library Standard Electromagnetic Propagation Model. It provides the user with a method of assessing the effects of the environment of the performance of a surface-search radar system. The software implementation of the model is written in ANSI FORTRAN 77, with MIL-STD-1753 extensions. The program provides the user with a table of expected detection ranges when the model is supplied with the proper environmental radar system inputs. The target model includes the variation in RCS as a function of aspect angle and the distribution of reflected radar energy as a function of height above the waterline. The modeled propagation effects include refraction caused by a multisegmented refractivity profile, sea-surface roughness caused by local winds, evaporation ducting, and surface-based ducts caused by atmospheric layering. GRA

**N91-20358#** Army Missile Command, Redstone Arsenal, AL. Advanced Sensors Directorate.
**SENSITIVITY TIME CONTROL LOSS Final Technical Report, Mar. - Sep. 1990**
Robert R. Boothe Oct. 1990 29 p
(AD-A229784; AD-E951579; AMSMI/TR-RD-AS-91-1) Avail: NTIS HC/MF A03 CSCL 17/9

The loss is determined which is associated with the use of sensitivity time control in a receiver. The receiver consists of three stages, the second stage of which incorporates the STC signal level control function. An example receiver is considered to illustrate the degree of STC loss that might be expected in a typical receiver. The loss is expressed in terms of the receiver's various noise figures, gains of each stage, and the range ratio. GRA

**N91-20359*#** Michigan Univ., Ann Arbor. Radiation Lab.
**A FINITE ELEMENT-BOUNDARY INTEGRAL METHOD FOR SCATTERING AND RADIATION BY TWO- AND THREE-DIMENSIONAL STRUCTURES**
Jian-Ming Jin, John L. Volakis, and Jeffery D. Collins Mar. 1991 39 p
(Grant NAG2-541)
(NASA-CR-188071; NAS 1.26:188071; UM-025921-20-T) Avail: NTIS HC/MF A03 CSCL 20N

A review of a hybrid finite element-boundary integral formulation for scattering and radiation by two- and three-dimensional composite structures is presented. In contrast to other hybrid techniques involving the finite element method, the proposed one is in principle exact and can be implemented using a low O(N) storage. This is of particular importance for large scale applications and is a characteristic of the boundary chosen to terminate the finite element mesh, usually as close to the structure as possible. A certain class of these boundaries lead to convolutional boundary integrals which can be evaluated via the fast Fourier transform (FFT) without a need to generate a matrix; thus, retaining the O(N) storage requirement. The paper begins with a general description of the method. A number of two- and three-dimensional applications are then given, including numerical computations which demonstrate the method's accuracy, efficiency, and capability. Author

**N91-20360*#** Polytechnic Univ., Farmingdale, NY.
**EXPERIMENT AND THEORETICAL STUDY OF THE PROPAGATION OF HIGH POWER MICROWAVE PULSE IN AIR BREAKDOWN ENVIRONMENT Semiannual Report**
S. P. Kuo, A. Ren, and Y. S. Zhang 1991 23 p
(Grant NAG5-1051)
(NASA-CR-188068; NAS 1.26:188068) Avail: NTIS HC/MF A03 CSCL 20N

In the study of the propagation of high power microwave pulse, one of the main concerns is how to minimize the energy loss of the pulse before reaching the destination. In the very high power region, one has to prevent the cutoff reflection caused by the excessive ionization in the background air. A frequency auto-conversion process which can lead to reflectionless propagation of powerful EM pulses in self-generated plasmas is studied. The theory shows that under the proper conditions the carrier frequency, omega, of the pulse will indeed shift upward with the growth of plasma frequency, omega(sub pe). Thus, the plasma during breakdown will always remain transparent to the pulse (i.e., omega greater than omega(sub pe)). A chamber experiment to demonstrate the frequency auto-conversion during the pulse propagation through the self-generated plasma is then conducted in a chamber. The detected frequency shift is compared with the theoretical result calculated y using the measured electron density distribution along the propagation path of the pulse. Good agreement between the theory and the experiment results is obtained. Author

**N91-20361#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**A METHOD OF MOMENTS SOLUTION FOR THE ELECTRIC CURRENTS ON AN APERTURE-FED, STACKED PATCH MICROSTRIP ANTENNA M.S. Thesis**
William L. Irvin Dec. 1990 177 p
(AD-A230466; AFIT/GE/ENG/90D-27) Avail: NTIS HC/MF A09 CSCL 09/1

This study presents a method of moments solution for the surface currents and charge distributions on an aperture-fed, stacked patch antenna. To make the solution independent of the antenna excitation technique, an aperture magnetic current distribution is assumed, and the spatial Green's functions of the antenna are used to calculate the tangential fields on the antenna patches and coefficients for a finite series expression of the surface currents and charge densities. The Green's functions of the antenna are modeled with polynomials that are a function of the radial distance separating observer and source locations. The method of moments solution is implemented using FORTRAN 77 and requires no external software support. The numerical techniques, algorithms, and complete software functional descriptions are also included. GRA

**N91-20362#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**SPEECH CODING AND COMPRESSION USING WAVELETS AND LATERAL INHIBITORY NETWORKS M.S. Thesis**
Richard Ricart Dec. 1990 177 p
(AD-A230499; AFIT/GE/ENG/90D-51) Avail: NTIS HC/MF A09 CSCL 20/1

The purpose of this thesis is to introduce the concept of lateral inhibition as a generalized technique for compressing time/frequency representations of electromagnetic and acoustical signals, particularly speech. This requires at least a rudimentary treatment of the theory of frames- which generalizes most commonly known time/frequency distributions -the biology of hearing, and digital signal processing. As such, this material, along with the interrelationships of the disparate subjects, is presented in a tutorial style. This may leave the mathematician longing for more rigor, the neurophysiological psychologist longing for more substantive support of the hypotheses presented, and the engineer longing for a reprieve from the theoretical barrage. Despite the problems that arise when trying to appeal to too wide an audience, this thesis should be a cogent analysis of the compression of time/frequency distributions via lateral inhibitory networks. GRA

**N91-20363#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**PREDICTING THE PERFORMANCE OF AIRBORNE ANTENNAS IN THE MICROWAVE REGIME M.S. Thesis**
David P. Carroll Dec. 1990 109 p
(AD-A230501; AFIT/GE/ENG/90D-10) Avail: NTIS HC/MF A06 CSCL 20/14

This study investigated the application of a high-frequency model (Uniform Geometrical Theory of Diffraction) of electromagnetic sources mounted on a curved surface of a complex structure. In particular, the purpose of the study was to determine if the model could be used to predict the radiation patterns of cavity-backed spiral antennas mounted on aircraft fuselages so that the optimum locations for the antennas could be chosen during the aircraft design phase. A review of literature revealed a good deal of work in modeling communications, navigation, identification antennas (blade monopoles and aperture slots) mounted on a wide variety of aircraft fuselages and successful validation against quarter-scale model measurements. This study developed a monopole-array model of a spiral antenna's radiation at vertical polarization and an ellipsoid-plate model of the FB-111A. Using the antenna and aircraft models, the existing Uniform Geometrical Theory of Diffraction model generated radiation patterns which agreed favorably with full-scale measured data. The study includes plots of predicted and measured radiation patterns from 2.5 to 15 Gigahertz. GRA

**N91-20364#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**RADAR IMAGE PROCESSING FOR THE AFIT ANECHOIC CHAMBER M.S. Thesis**
Brian K. Sanders Dec. 1990 102 p
(AD-A230502; AFIT/GE/ENG/90D-54) Avail: NTIS HC/MF A06 CSCL 17/9

The purpose of this study was to begin development of an Inverse Synthetic Aperature Radar imaging capability for the AFIT anechoic chamber. This began with an evaluation of the capabilities and limitations of the existing radar system and the chamber itself for this application. Then, after deciding on the image processing approach, software had to be written to collect the data necessary for image processing. This constituted the majority of this study, and resulted in a versatile, user-friendly program that automates the process of collecting data for high-resolution radar images. The program checks that the data to be collected will lead to a valid radar cross-section (RCS) image, but will allow data collection for general radar images. Finally, the image processing software was begun. This made use of commercially available software packages called PC-MATLAB and PRO-MATLAB. Further work is needed on the image processing software to generate calibrated images, and to perform focusing. GRA

**N91-20365#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**PULSED COMPRESSION FOR AEROSOL RANGING WITH COHERENT PULSE-DOPPLER LIDAR SYSTEMS M.S. Thesis**
Jerry L. Rogers Dec. 1990 105 p
(AD-A230514; AFIT/GE/ENG/90D-52) Avail: NTIS HC/MF A06 CSCL 17/5

This thesis provides a thorough review of conventional matched filter radar theory as it applies to aerosol sensing lidar. Basic matched-filter radar theory and the complex, dense aerosol target model eventually lead to a general derivation of the matched-filter radar receiver response to a dense aerosol target environment. The matched-filter response is obtained in terms of a two dimensional convolution of the target scattering function and the radar ambiguity function. The range and radial velocity resolution of various radar signals were compared using the matched-filter radar receiver and scattering function models. Pulse compression radar signals were compared to the simple radar pulses currently in use with existing lidar systems, and in each case, the pulse compression radar signal did not provide a significant improvement in combined range and radial velocity resolution. GRA

**N91-20366#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**ON RADAR RECEIVERS M.S. Thesis**
Paul E. Bishop Dec. 1990 119 p
(AD-A230525; AFIT/GE/ENG/90D-05) Avail: NTIS HC/MF A06 CSCL 17/4

A comprehensive study of the effects of noise jamming on various pulsed radar receiver types is proposed. First, a literature review on the sources of electrical noise and various jamming waveforms is presented. The power spectra for three noise jamming waveforms are rigorously derived. These cases are shot noise in a parallel-plate diode, a series of pulses with random amplitudes and intervals, and for a series of pulses with random amplitudes, spacing and phases. Next, the probability density functions for the output of linear and quadratic detectors are developed. For each detector type, the probability density functions for the cases of noise only and signal plus noise are derived. Finally, the effects of CW interference on conventional pulsed radar receivers is accomplished. This analysis shows that the effect of pure CW tone is detuned from the signal carrier frequency the minimum power required for detection increases until the detuning is so great that the effects of the CW is negligible. This thesis lays the ground work for a much broader future study of the effects of noise jamming on various pulsed radar receivers types. GRA

**N91-20367#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**ELECTROMAGNETIC SCATTERING FROM IMPEDANCE STRIPS AND IMPEDANCE-LOADED CONDUCTING STRIPS M.S. Thesis**
Mark C. Heaton Dec. 1990 128 p
(AD-A230526; AFIT/GE/ENG/90D-26) Avail: NTIS HC/MF A07 CSCL 20/14

This paper investigates the scattering from impedance strips and impedance-loaded conducting strips. The UTD diffraction coefficient for an edge in a conductor is heuristically modified for impedance edges and junctions. Essentially, this is done by scaling the UTD diffraction coefficients according to changes in the geometrical optics field. The new diffraction coefficients are then used to investigate the scattering from impedance strips and impedance-loaded conducting strips. Both uniform and tapered impedances are considered. Results are compared to moment method and physical optics predictions and to measured data. The scattering pattern of a uniform impedance strip was seen to behave as that for a conducting strip, but at a lower level. However, tapering the impedance was seen to significantly decrease the sidelobe levels relative to the main lobe. Also, applying an impedance load to a conducting strip reduced the sidelobe levels. This was most pronounced for loads of tapered impedance. The modified UTD approach accurately predicted the sidelobe levels and locations for the simple impedance strips, and worked fairly well for the impedance-loaded conducting strips. The predictions for all geometries were better near broadside incidence than near edge-on. GRA

**N91-20368#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**ESTABLISHMENT OF A FABRICATION AND MEASUREMENT CAPABILITY FOR APERTURE-FED STACKED PATCH MICROSTRIP ANTENNAS AT THE AIR FORCE INSTITUTE OF TECHNOLOGY M.S. Thesis**
Christopher I. Terry Dec. 1990 90 p
(AD-A230531; AFIT/GE/ENG/90D-61) Avail: NTIS HC/MF A05 CSCL 09/1

Much time and effort was applied to accurately model aperture-fed stacked patch microstrip antennas. The results provide AFIT with the capability to fabricate and measure these antennas for comparison of measured radiation characteristics to the predicted characteristics. Basic microstrip patch antenna theory is reviewed, as well as the motivation leading to the development of aperture-fed stacked patch microstrip antennas. The fabrication process used to produce the two antennas manufactured is described in detail. The construction of a small anechoic chamber for pattern measurements is discussed, and measurements of the return loss, VSWR, input impedance, and principal plane radiation patterns for the two antennas are provided. Although the two fabricated antennas did not operate optimally due to under cutting during the etching process, the measurement results show the broader bandwidth characteristic of the stacked patch design. The results are most useful as a guide to researchers starting an active microstrip patch antenna investigation. GRA

**N91-20369#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**DETECTION OF HIGH ALTITUDE AIRCRAFT WAKE VORTICES USING INFRARED DOPPLER LIDAR: AN ASSESSMENT M.S. Thesis**
Michael J. Estes Dec. 1990 149 p
(AD-A230534; AFIT/GEO/ENP/90D-1) Avail: NTIS HC/MF A07 CSCL 17/5

The feasibility is studied of air-to-air detection of high altitude aircraft wake vortices at long ranges using infrared Doppler lidar. The purpose of this technique is to detect otherwise stealthy aircraft. Three laser wavelengths were analyzed: 1.064, 2.091, and 9.115 microns. Analysis revealed that the spectral width of the return signal from an aircraft wake presented a good signature for detection. Based on the analysis, a minimum signal-to-noise ratio of 0 db was established. Detection performance was then analyzed using signal-to-noise ratio calculations for backscatter by ambient atmospheric aerosols, jet engine exhaust soot particles, and condensation trail ice particles. Results indicated that atmospheric aerosols alone were not sufficient for detection in clean atmospheric regions. Backscatter enhancement by soot particles did, however, appear to be sufficient for detection out to 80 km. Enhancement by condensed ice particles in wake contrails provided detection well beyond 100 km in range. Interestingly, the shorter wavelength lidars did not perform as well as the 9.115 micron lidar due to degradations from shot noise, wavefront mismatch, refractive turbulence, and atmospheric extinction. GRA

**N91-20370#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**USING ERROR DETECTION AND CORRECTION CODING FOR A TURBULENT ATMOSPHERIC OPTICAL COMMUNICATIONS LINK M.S. Thesis**
Mark A. Cloutier Dec. 1990 101 p
(AD-A230540; AFIT/GEO/ENG/90D-3) Avail: NTIS HC/MF A06 CSCL 12/5

Probability of bit error (Pb) performance for a turbulent, atmospheric, optical, communications link with convolutional error detection and correction coding was investigated. The codes investigated were all rate 1/2 codes with constraint lengths ranging from 3 to 7. It was assumed that the coded data stream was sufficiently interleaved so that the turbulent channel could be considered memoryless. A theoretical bound on P sub b, given by Viterbi for a memoryless channel, was used to plot curves of P sub b versus the signal intensity of last transmitter. These curves were plotted for three different levels of atmospheric turbulence and three different levels of background light. GRA

**N91-20371#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**GABOR FILTERS AND NEURAL NETWORKS FOR SEGMENTATION OF SYNTHETIC APERTURE RADAR IMAGERY M.S. Thesis**
Albert P. LHomme Dec. 1990 117 p
(AD-A230580; AFIT/GE/ENG/90D-31) Avail: NTIS HC/MF A06 CSCL 17/9

This research investigates Gabor filters and artificial networks for autonomous segmentation of (1 foot by 1 foot) high resolution polarimetric synthetic aperture radar (SAR). Processing involved frequency correlation between the SAR imagery and biologically motivated Gabor functions. Methods for selecting the Gabor tuning parameters from the endless choices of frequency, rotation, standard deviation and bandwidth are discussed. Using these parameters, resulting Gabor correlation images were reduced in speckle, and more detailed. This research used cosine Gabor functions and operated on single polarization HH magnitude data. Following selection of the appropriate Gabor features, multiple Gabor representations were generated and converted for ANN training. Networks investigated were the Kohonen and radial basis function (RBF) algorithms. Provided are results demonstrating a Kohonen network calibration technique and how combination of Gabor processing and RBF networks provide scene segmentation. GRA

**N91-20372#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**CHARACTERIZATION OF RADAR SIGNALS USING NEURAL NETWORKS M.S. Thesis**
Daniel R. Zahirniak Dec. 1990 289 p
(AD-A230582; AFIT/GAE/ENG/90D-69) Avail: NTIS HC/MF A13 CSCL 17/9

Recent work concerning artificial neural networks has focused on decreasing network training times. Kernel Classifier networks, using radial basis functions (RBFs) as the kernel function, can be trained quickly with little performance degradation. Short training times are critical for systems which must adapt to changing environments. The function of Kernel Classifier networks is based on the principle that multivariate functions can be approximated

via linear combinations of RBFs. RBFs can also perform probability density estimations, making classifications approximating a Baye's optimal descriminant. Methods used to set the RBF centers included matching the training data, Kohonen Training, K-Means Clustering and placement at averages of data clusters of the same class. Test results indicate the performance of these networks was equal to that of Hyperplane Classifier networks trained, via backpropagation, to optimize the Mean Square Error, Cross Entropy, and Classification Figure of Merit objective functions. However, the RBF networks trained much faster. The RBF networks also outperformed the Probability Neural Networks, (PNN) indicating the weights in the output layer offset the choice of non-optimal spreads. This ability to train quickly while obtaining high classification accuracies make RBF Kernel Classifier networks an attractive option for systems which must adapt quickly to changing environments. GRA

**N91-20373#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**INTERFERENCE CANCELLATION IN RF SIGNALS USING ADAPTIVE ARRAY TECHNIQUES M.S. Thesis**

Mark E. Brown Dec. 1990 66 p

(AD-A230587; AFIT/GE/ENG/90D-08) Avail: NTIS HC/MF A04 CSCL 17/4

This study investigated the effectiveness of the least means squared (LMS) algorithm against various types of common jammers. The LMS algorithm was implemented using the block oriented systems simulator (BOSS). The LMS algorithm was inserted at the output of a two element antenna array. The array was configured so as to have one-half wavelength spacing. A quadrature hybrid signal structure was used. The array was then tested against a barrage and sweep jammer. The barrage jammer testing consisted of varying each of the three available jammer parameters: power, frequency, and angle of arrival individually. The sweep jammer testing consisted of varying each of the three available jammer parameters; power, sweep frequency and angle of arrival individually. The results of the simulation showed the LMS algorithm in combination with the quadrature hybrid was very effective against both the barrage and sweep jammers. It provided a 55 dB null in the barrage jammer cases and a 50 dB null in the sweep jammer case. GRA

**N91-20374#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.

**TE SCATTERING FROM A DIELECTRIC COATED CONDUCTING STRIP M.S. Thesis**

William D. Wood, Jr. Dec. 1990 88 p

(AD-A230612; AFIT/GE/ENG/90D-67) Avail: NTIS HC/MF A05 CSCL 20/14

Consider a plane wave incident on a conducting strip of infinite length coated on one side with a thin, uniform coating of lossless dielectric, and let the incident magnetic field vector be parallel to the edges of the strip. From first principles, we develop the integral equations relating the total, incident, and scattered fields in the dielectric. We expand the fields in the dielectric slab as the sum of three plane waves (the 'forced' wave and two oppositely-directed surface waves). The phase constants in the x and y directions are known and the wave amplitudes are found using least-squared-error-point-matching. The far-zone scattered field is found by letting the polarization and conduction currents radiate in free space. Data are presented showing the bistatic scattering characteristics of the dielectric-coated conducting strip as a function of dielectric permittivity, slab width and thickness, and angle of incidence. Results show reasonable agreement with conventional moment method solution using pulse bases and Galerkin testing functions. GRA

**N91-20375#** California Univ., Los Angeles. Inst. of Geophysics and Planetary Physics.

**ELF DETECTION OF ENERGETIC PARTICLE PRECIPITATION Final Report, 25 Nov. 1988 - 28 Feb. 1990**

D. D. Sentman 25 Jul. 1990 30 p

(Contract F19628-89-K-0004)

(AD-A230632; GL-TR-90-0135) Avail: NTIS HC/MF A03 CSCL 20/14

The scientific objective of this project was to investigate the effects of relativistic electron precipitation on the characteristics of the Schumann resonances. The method of investigation was to establish a Schumann resonance and ELF observing station in Alaska to provide high-latitude measurements for comparison against similar measurements made at midlatitude stations in California and Australia. Observations of Schumann resonance eigenfrequencies and Q-factors during May to October, 1989 showed discontinuous changes that correlated well with the occurrence of several large solar events that produced notable enhancements in the intensities of magnetospheric relativistic electrons 1.2 less than E sub e less than 2 MeV, energetic protons E sub p greater than 1 MeV, and solar x rays 0.5 to 8A. The observed correlation suggests that the solar events produced a globally significant perturbation in the conductivity of the D-region forming the upper boundary of the earth-ionosphere cavity to produce the observed Schumann resonance response. A more refined analysis of the data will permit establishing the relative importance of the relativistic electron, energetic proton and x ray contributions to the observed perturbations. In addition to making Schumann resonance measurements, the station in Alaska successfully detected for the first time ALF emissions in the frequency range 6 to 154 Hz generated by polar electrojet modification by the HIPAS HF heater facility located near Fairbanks. GRA

**N91-20376#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.

**CLASSIFICATION OF CORRELATION SIGNATURES OF SPREAD SPECTRUM SIGNALS USING NEURAL NETWORKS M.S. Thesis**

Richard A. Chapman Dec. 1990 135 p

(AD-A230663; AFIT/GE/ENG/90D-11) Avail: NTIS HC/MF A07 CSCL 09/1

The major goals of this thesis were to determine if Artificial Neural Networks (ANNs) could be trained to classify the correlation signatures of two classes of spread spectrum signals and four classes of spread spectrum signals. Also, the possibility of training an ANN to classify features of the signatures other than signal class was investigated. Radial Basis Function Networks and Back-Propagation Networks were used for the classification problems. Correlation signatures of four types or classes were obtained from United States Army Harry Diamond Laboratories. The four types are as follows: direct sequence (DS), linearly-stepped frequency hopped (LSFH), randomly-driven frequency hopped (RDFH), and a hybrid of direct sequence and randomly-driven frequency hopped (HYB). These signatures were preprocessed and separated into various training and test data sets for presentation to neural networks. Radial Basis Function Networks and Back-Propagation Networks trained directly on two classes (DS and LSFH) and four classes (DS, LSFH, RDFH, and HYB) of correlation signatures. Classification accuracies ranged from 79 to 92 percent for the two class problem and from 70 to 76 percent for the four class problem. The Radial Basis Function Networks consistently produced classification accuracies from 5 to 10 percent higher than accuracies produced by the Back-Propagation Networks. The Radial Basis Function Networks produced this classification advantage in significantly less training time for all cases. GRA

**N91-20377#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.

**QUANTIZATION NOISE CHARACTERISTICS RESULTING FROM GAUSSIAN, NEGATIVE-EXPONENTIAL, AND SINUSOIDAL RANDOM INPUT SIGNALS M.S. Thesis**

Van N. Osborne Dec. 1990 119 p

(AD-A230664; AFIT/GE/ENG/90D-48) Avail: NTIS HC/MF A06 CSCL 25/2

The purpose of this study was to investigate the trade-off between the number of quantization levels and the resulting noise

characteristics for three classes of commonly occurring input signals, namely, those signals possessing Gaussian, negative-exponential and random sinusoidal distributions. This study derived expressions for the mean-squared error, output spectrum and error spectrum by expanding the nonlinear quantization function into a summation of orthogonal polynomials matched to the corresponding input signal distribution. Once accomplished, orthogonality properties were applied to provide usable expressions. A set of three Fortran 77 programs were developed-each of which applied to one of the studied input signal classes. The appropriate program produced upon demand either a mean-squared error value and a signal-to-quantization noise ratio or quantizer output spectrum data and quantization error spectrum data. Typical input power spectral densities were applied in order to produce the spectra data. The study resulted in a set of tables which provided mean-squared error and signal-to-quantization noise ratio data based on various numbers of bits used for the quantization process. Also, a number of plots displaying the power spectral densities under consideration were produced as based on similar numbers of bits. GRA

**N91-20378#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**CHARACTERIZATION OF AN AIR-TO-AIR OPTICAL HETERODYNE COMMUNICATION SYSTEM M.S. Thesis**
Rebecca N. Seeger Dec. 1990 126 p
(AD-A230681; AFIT/GE/ENG/90D-55) Avail: NTIS HC/MF A07 CSCL 20/6

The primary goal of this research was to determine the feasibility of air-to-air optical communications systems using coherent detection in a turbulent environment. Secondary goals were to determine: (1) the signal-to-noise ratio (SNR) degradation due to turbulence, and (2) the effect of varying the wavelength (1.5, 830, 904 nm), altitude (5000 to 12500 m), path length (40 to 160 km) and aperture side length (1 to 15 cm) on the turbulence affected SNR. The research was conducted under the following assumptions: (1) ideal transmitter and receiver, (2) equally sized, uniformly weighted, square transmitter and receiver apertures, (3) ideal tracking by the receiver, and (4) zero losses due to beam steering, beam spreading and scintillation. It was shown that the SNR efficiency (defined as the ratio of the turbulence affected SNR to the non-turbulence affected SNR) ranged from 0.16 to 67.2 percent. The 67.2 percent efficiency was achieved for a wavelength of 904 nm, path length of 40 km, altitude of 5000 m and aperture side length of 1 cm. GRA

**N91-20379#** Naval Oceanographic and Atmospheric Research Lab., Bay Saint Louis, MS.
**TRANSIENT SIGNAL DISTORTION IN A MULTIPATH ENVIRONMENT**
R. L. Field 1990 5 p
(AD-A230737; NOARL-PR-90-037-244) Avail: NTIS HC/MF A01 CSCL 17/1

The classification of transient signals is facilitated if propagational distortion is removed. This distortion can be removed if the ocean impulse response from source to receiver is known. The ocean impulse response is, however, very sensitive to source location and the ocean environment. It is shown that for a bottom-mounted receiver and almost normal incidence, distortion of a 244-Hz transient signal envelope can be accounted for if the time delays and relative amplitudes of the ocean impulse response are accurately known. These time delays and amplitudes are extracted from transient data for the known source case. This work provides the motivation for the development of high-resolution, time-delay estimation algorithms to be presented in a companion paper. These algorithms will be tested on the data presented in this paper for the unknown source case. GRA

**N91-20380#** Naval Oceanographic and Atmospheric Research Lab., Bay Saint Louis, MS.
**PERFORMANCE OF NEURAL NETWORKS IN CLASSIFYING ENVIRONMENTALLY DISTORTED TRANSIENT SIGNALS**
R. L. Field, E. J. Yoerger, and P. K. Simpson 1990 6 p
(AD-A230739; NOARL-PR-90-029-244) Avail: NTIS HC/MF A02 CSCL 17/1

Neutral networks have been showing great promise in several areas, one of which is the classification of underwater acoustic transients. The classification of low-frequency underwater acoustic transient signals using a neural network based system is investigated. The received acoustic transients are simulated using a time-domain parabolic equation model. The neural network is trained on three source signals and tested by classifying the same signals at 25 different receiver locations in a noise-free, range-dependent (upslope) environment. Overall classification performance is above 90 percent. GRA

**N91-20381#** California Univ., San Diego, La Jolla. Dept. of Electrical and Computer Engineering.
**THE PRODUCTION AND MODIFICATION OF IONOSPHERIC IRREGULARITIES BY POWERFUL HF RADIO TRANSMISSIONS Final Report, 1 Aug. 1986 - 31 Jul. 1989**
Jules A. Fejer 11 Sep. 1990 72 p
(Contract F19628-86-K-0031)
(AD-A230766; GL-TR-90-0052) Avail: NTIS HC/MF A04 CSCL 17/9

Several types of active experiments were performed with the high power HF heater near Arecibo, Puerto Rico. The temporal behavior of suprathermal electron fluxes was studied by observing the 430 MHz radar backscatter from ionospheric Langmuir waves that were Cerenkov emitted by the suprathermal electrons during pulse operation of the HF heater. Coded radar pulse techniques were used to study the height dependence of radar backscatter from Langmuir turbulence for both CW and pulsed HF heating. Observations with the 430 MHz radar of the power backscattered from HF induced Langmuir turbulence with a temporal resolution of 1 ms sometimes showed almost periodic short bursts of power at time intervals of 20 to 50 ms. The observational limitations on the role of strong Langmuir caviton turbulence were pointed out and the important role of field aligned depletions of the plasma density were stressed in accounting for the observed height dependence of the 430 MHz radar backscatter and for nature of the observed 46.8 MHz radar backscatter. GRA

**N91-20382#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**RULE-BASED FREQUENCY DOMAIN SPEECH CODING M.S. Thesis**
Vance M. McMillan Dec. 1990 107 p
(AD-A230774; AFIT/GE/ENG/90D-38) Avail: NTIS HC/MF A06 CSCL 25/4

A speech processing system is designed to simulate the transmission of speech signals using a speech coding scheme. The transmitter portion of the simulation extracts a minimized set of frequencies in Fourier space which represents the essence of each of the speech timeslices. These parameters are then adaptively quantized and transmitted to a receiver portion of the coding scheme. The receiver then generates an estimate of the original timeslice from the transmitted parameters using a sinusoidal speech model. After initial design, how each of the design parameters affect the human perceived quality of speech is studied. This is done with listening tests. The listening tests consist of having volunteers listen to a series of speech reconstructions. Each reconstruction is the result of the coding scheme acting on the same speech input file with the design parameters varied. The design parameters which are varied are: number of frequencies used in the sinusoidal speech model for reconstruction, number of bits to encode amplitude information, and number of bits used to code phase information. The final design parameters for the coding scheme were selected based on the results of the listening tests. Post design listening tests showed that the system was capable of 4800 bps speech transmission with a quality rating of five on a scale from zero (not understandable) to ten (sounds just like original speech). GRA

**N91-20383#** Ecole Nationale Superieure des Telecommunications, Paris (France).
**A KNOWLEDGE BASE RECOGNITION SYSTEM SPEECH SPECTROGRAM INTERPRETATION Ph.D. Thesis [UN SYSTEME DE RECONNAISSANCE DES FORMES A BASE DE CONNAISSANCES POUR L'INTERPRETATION DE SPECTROGRAMMES DE PAROLE]**
Xuan-Shi Wang 1990 188 p In FRENCH
(TELECOM-90-E-006; ISSN-0751-1353; ETN-91-98901) Avail: NTIS HC/MF A09

Spectrogram analysis used to better understand the factors involved in speech recognition is discussed. Interpretation systems destined for a particular task are developed. The systems analyze the data in order to simulate the work carried out by the spectrogram receptor. Segmentation of spectrograms into phonemes by the system is the main technique used. Numeric analysis methods are used in studying the phonetic and perceptive aspects of the problem. ESA

**N91-20384#** Royal Aerospace Establishment, Farnborough (England).
**RAE BEDFORD'S EXPERIENCE OF USING DIRECT VOICE INPUT (DVI) IN THE COCKPIT**
N. Cooke 6 Jun. 1990 27 p Presented at the Voice Systems Worldwide Conference Military Applications Session, London, England, May 1990
(RAE-TM-FM-43; BR115495; ETN-91-99008) Copyright Avail: NTIS HC/MF A03

Research of automatic speech recognition in an aircraft cockpit is described. A BAC 1-11 aircraft was used and research concerned the civil flight deck. Lessons learned are outlined and referred to military operations. Trials underway using a Tornado GR1 are described. DV1 is shown to be feasible in the relative quiet of the civil cockpit and possible improvements, which are essential for military viability are given. Tables listing the recognition results are provided. ESA

**N91-20385#** Royal Aerospace Establishment, Farnborough (England).
**EVALUATION OF VIRTUAL COCKPIT CONCEPTS DURING SIMULATED MISSIONS**
M. G. Kaye, Judith Ineson, D. N. Jarett, and G. Wickham 9 Apr. 1990 16 p Presented at the SPIE Helmet-Mounted Displays 2 Conference, Orlando, FL, 12-20 Apr. 1990
(RAE-TM-MM-36; BR115970; ETN-91-99009) Copyright Avail: NTIS HC/MF A03

The Virtual Environment Integration Laboratory (VEIL) of the Royal Aerospace Establishement (RAE) is described. The VEIL program is intended to provoke appropriate technological developments by exploring the human requirements of operating within a virtual cockpit whilst conducting demanding missions. Under construction is a lightweight binocular, color helmet mounted display with a wide field of view, driven by a versatile parallel architecture computer graphic system which accommodates simulated sensor images from a camera and terrain model. Prototypes of suitable display formats will be developed using a bench mounted stereoscopic viewing rig which will also facilitate investigation of critical psychophysical issues. The complete VEIL hardware will integrate eye and head position sensors, three dimensional sound, direct voice input, and tactile sensors with the binocular display system. When allied to the ground attack, helicopter and air combat simulator facilities of Mission Management Department, it will enable the practicality of operating virtual cockpit systems in a wide variety of missions and tasks to be addressed. ESA

**N91-20386** National Physical Lab., Teddington (England). Div. of Electrical Science.
**THE OPTIMUM RANGE OF SEPARATIONS FOR ANTENNA GAIN MEASUREMENT BY EXTRAPOLATION**
R. E. Borland Sep. 1990 10 p
(NPL-DES-90; ISSN-0143-7305; ETN-91-99026) Copyright Avail: National Physical Lab., Teddington, Middlesex, TW11 0LW, England

The extrapolation technique is probably the most accurate method for the measurement of the gain of microwave antennas. However, it is important to choose the fitting polynomial and range of separations with some care. This choice is discussed and the result of studies which show that the smallest uncertainty is normally obtained using a fairly low order polynomial is reported. A three term polynomial is usually best. A four term polynomial should be used only when the extrapolation range permits very accurate measurements. ESA

**N91-20387#** Lawrence Livermore National Lab., CA.
**EVALUATION OF MODIFIED LOG-PERIODIC ANTENNAS FOR TRANSMISSION OF WIDE-BAND PULSES**
G. J. Burke 31 Jan. 1991 12 p Presented at the 7th Annual Review of Progress in Applied Computational Electromagnetics, Monterey, CA, 19-21 Mar. 1991
(Contract W-7405-eng-48)
(DE91-008455; UCRL-JC-105655; CONF-9103123-2) Avail: NTIS HC/MF A03

Modified forms of the long-periodic dipole antenna have been proposed in the literature for radiating a short pulse with minimum distortion and also for a phase response tailored to compress a linear FM pulse. These designs are reviewed, and the antennas are evaluated by numerical modeling with the frequency domain code NEC. Responses for transient input signals are obtained from the NEC solution by inverse transforming and convolution. Antennas modified to obtain a linear phase characteristic are seen to be effective in transmitting an input pulse with minimum distortion. The antennas for compressing a linear FM pulse are somewhat effective but do not appear to work as well as might be expected. DOE

**N91-20388#** Lawrence Livermore National Lab., CA.
**A NEW WEIGHTED RESIDUAL FINITE ELEMENT METHOD FOR COMPUTATIONAL ELECTROMAGNETICS IN THE TIME DOMAIN**
J. J. Ambrosiano, S. T. Brandon, and R. Loehner (George Washington Univ., Washington, DC.) Feb. 1991 14 p Presented at the 7th Annual Review of Progress in Applied Computational Electromagnetics, Monterey, CA, 19-21 Mar. 1991
(Contract W-7405-eng-48)
(DE91-008741; UCRL-JC-106408; CONF-9103123-3) Avail: NTIS HC/MF A03

Engineers and scientists have become increasingly interested in calculating electromagnetic effects in the time domain. For example, the time domain is especially convenient for studying short (wide band) pulses. For such methods to be generally useful, they must be free of the severe geometric restrictions imposed by traditional finite difference methods. In our research into methods for plasma simulations in realistic geometries, we have developed finite element methods for electromagnetics in the time domain on unstructured grids. Unstructured grids provide maximum flexibility in fitting sample points to the problem, both on boundaries and in the interior. Finite elements provide the most convenient framework for the mathematics as well as for the implementation. We will present a new finite element method for computational electromagnetics on unstructured grids. The method is fast, easy to implement, and 2nd-order accurate. Although we use low-order elements, the method can be shown to preserve the divergence constraints (del x B = 0, del x E = 0 in vacuum). We also present a numerical benchmark. DOE

**N91-20389#** Sao Paulo Univ. (Brazil). Inst. de Fisica.
**THEORY OF THE WEAK INTERACTION VERTICES**
I. Ventura May 1990 14 p
(DE91-616920; IFUSP-P-851) Avail: NTIS HC/MF A03

A manner of introducing the magnetic field of the electron, by means of another flux operator factor, which will be called the ampere mode is proposed. The explicit differentiation of the Ampere mode in the kinetic Hamiltonian, generates a second type of interaction, showing the mathematical structure of the weak

interactions. This result is explored to build up a theory of the weak interaction vertices. The proposed theory is then compared with the theory of Weinberg-Salam. DOE

**N91-20390*#** Contel Federal Systems, Inc., Chantilly, VA. Government Networks Group.
**DIRECT BROADCAST SATELLITE-RADIO MARKET, LEGAL, REGULATORY, AND BUSINESS CONSIDERATIONS Summary Report**
Des R. Sood Mar. 1991 115 p
(Contract NAS3-25083)
(NASA-CR-187093; NAS 1.26:187093) Avail: NTIS HC/MF A06 CSCL 17B

A Direct Broadcast Satellite-Radio (DBS-R) System offers the prospect of delivering high quality audio broadcasts to large audiences at costs lower than or comparable to those incurred using the current means of broadcasting. The maturation of mobile communications technologies, and advances in microelectronics and digital signal processing now make it possible to bring this technology to the marketplace. Heightened consumer interest in improved audio quality coupled with the technological and economic feasibility of meeting this demand via DBS-R make it opportune to start planning for implementation of DBS-R Systems. NASA-Lewis and the Voice of America as part of their on-going efforts to improve the quality of international audio broadcasts, have undertaken a number of tasks to more clearly define the technical, marketing, organizational, legal, and regulatory issues underlying implementation of DBS-R Systems. The results and an assessment is presented of the business considerations underlying the construction, launch, and operation of DBS-R Systems.
Author

**N91-20723*#** Toronto Univ. (Ontario). Dept. of Electrical Engineering.
**MAGNETOPLASMA SHEATH WAVES ON A CONDUCTING TETHER IN THE IONOSPHERE WITH APPLICATIONS TO EMI PROPAGATION ON LARGE SPACE STRUCTURES**
K. G. Balmain, H. G. James (Communications Research Centre, Ottawa, Ontario ), and C. C. Bantin *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 646-654 Sponsored in part by National Research Council of Canada; Natural Sciences and Engineering Research Council of Canada; and Institute for Space and Terrestrial Science, Ontario (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 17B

# 33 ELECTRONICS AND ELECTRICAL ENGINEERING

Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry.

For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics.*

**N91-20391** Department of the Navy, Washington, DC.
**ELECTROACOUSTIC TRANSDUCER Patent**
Rufus L. Cook, inventor (to Navy) 16 Oct. 1990 7 p Filed 5 Oct. 1970
(AD-D014721; US-Patent-4,964,091; US-Patent-Appl-SN-078284; US-Patent-Class-367-165) Avail: US Patent and Trademark Office CSCL 09/1

This patent pertains to the electroacoustic transducer arts and discloses an improved physical construction in which a honeycomb-like member is issued to secure both pressure release and thermal transfer for the converting element. GRA

**N91-20392*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**HETEROEPITAXIAL InP SOLAR CELLS ON Si AND GaAs SUBSTRATES**
Irving Weinberg, Clifford K. Swartz, and David J. Brinker 1990 7 p Presented at the 5th International Photovoltaic Science and Engineering Conference, Kyoto, Japan, 26-30 Nov. 1990; sponsored by the Japan Society of Applied Physics, Inst. of Electrical Engineers of Japan, and the Foundation for the Advancement of In
(NASA-TM-103696; E-5918; NAS 1.15:103696) Avail: NTIS HC/MF A02 CSCL 10A

The characteristics of InP cells processed from thin layers of InP heteroepitaxially grown on GaAs, on silicon with an intervening GaAs layer, and on GaAs with intervening Ga(x)In(1-x)As layers are described, and the factors affecting cell efficiency are discussed. Under 10 MeV proton irradiations, the radiation resistances of the heteroepitaxial cells were superior to that of homoepitaxial InP cells. The superior radiation resistance is attributed to the high dislocation densities present in the heteroepitaxial cells. Author

**N91-20393*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**NEAR-FIELD ANTENNA TESTING USING THE HEWLETT PACKARD 8510 AUTOMATED NETWORK ANALYZER**
Richard R. Kunath and Michael J. Garrett (Ohio State Univ., Columbus.) 1990 10 p Presented at the Antenna Measurement Techniques Association Meeting, Philadelphia, PA, 8-11 Oct. 1990
(NASA-TM-103699; E-5921; NAS 1.15:103699) Avail: NTIS HC/MF A02 CSCL 20N

Near-field antenna measurements were made using a Hewlett-Packard 8510 automated network analyzer. This system features measurement sensitivity better than -90 dBm, at measurement speeds of one data point per millisecond in the fast data acquisition mode. The system was configured using external, even harmonic mixers and a fiber optic distributed local oscillator signal. Additionally, the time domain capability of the HP8510, made it possible to generate far-field diagnostic results immediately after data acquisition without the use of an external computer.
Author

**N91-20394*#** Analex Corp., Fairview Park, OH.
**DESCRIPTION AND OPERATION OF A MICROWAVE REFLECTANCE MEASUREMENT SYSTEM Final Report**
Kevin M. Lambert Feb. 1991 17 p
(Contract NAS3-25776)
(NASA-CR-187063; E-5985; NAS 1.26:187063) Avail: NTIS HC/MF A03 CSCL 09C

A recent effort at the NASA Lewis Research Center (LeRC), Microwave System Laboratory was to develop the capability to perform farfield reflectance measurements. This effort has resulted, to date, in a system that can perform X-band, monostatic, measurements of test objects. The system and the measurement procedure are described. Data are presented which assists in the evaluation of the quality of the measurements obtained with the system. GRA

**N91-20395*#** Old Dominion Univ., Norfolk, VA.
**STRATEGIES FOR CONCURRENT PROCESSING OF COMPLEX ALGORITHMS IN DATA DRIVEN ARCHITECTURES Final Report, May 1988 - Aug. 1989**
Sukhamoy Som, John W. Stoughton, and Roland R. Mielke Oct. 1990 178 p
(Grant NAG1-683)
(NASA-CR-187450; NAS 1.26:187450) Avail: NTIS HC/MF A09 CSCL 09C

Performance modeling and performance enhancement for periodic execution of large-grain, decision-free algorithms in data flow architectures are discussed. Applications include real-time implementation of control and signal processing algorithms where performance is required to be highly predictable. The mapping of algorithms onto the specified class of data flow architectures is realized by a marked graph model called algorithm to architecture mapping model (ATAMM). Performance measures and bounds are established. Algorithm transformation techniques are identified for performance enhancement and reduction of resource (computing

element) requirements. A systematic design procedure is described for generating operating conditions for predictable performance both with and without resource constraints. An ATAMM simulator is used to test and validate the performance prediction by the design procedure. Experiments on a three resource testbed provide verification of the ATAMM model and the design procedure.
Author

**N91-20396** Tel-Aviv Univ. (Israel).
**DISCRETE-TIME FILTERING OF LINEAR CONTINUOUS-TIME PROCESSES Ph.D. Thesis**
Samuel Shats Jun. 1989 140 p
(ITN-91-85097) Copyright Avail: Tel-Aviv Univ., Exact Sciences Library, Ramat Aviv 69978, Israel

Continuous-time measurements are prefiltered before sampling, to remove additive white noise. The discrete-time optimal filter comprises a digital algorithm which is applied to the prefiltered, sampled measurements; the algorithm is based on the discrete-time equivalent model of the overall system. For the case of an integrate-and-dump analog prefilter, a discrete-time equivalent model was developed and the corresponding optimal filter was found for the general case, where the continuous-time measurement and process noise signals are correlated. A commonly used approximate discrete-time model was analyzed by defining and evaluating the true-error-covariance matrix of the estimate, and comparing it with the supposed error covariance matrix. It was shown that there is a class of unstable processes for which the former error covariance matrix attains unbounded norm, in spite of the continuing bounded nature of the other error covariance matrix. The main part of the thesis concerns the problem of finding an optimal prefilter. The steps of obtaining the optimal prefilter comprise: deriving a discrete-time equivalent-model of the overall system; finding the equation which is satisfied by the error covariance matrix; deriving the expressions which are satisfied by the first coefficients of the Maclaurin expansions of the error covariance matrix in the small parameter T; and obtaining the optimal prefilter by matrix optimization. The results obtained indicate that the optimal prefilter may be implemented through systems of different orders; the minimum order required is discussed, which is of great practical importance as the simplest possible prefilter. In discussion of the problem of discrete-time quadratic regulation of linear continuous time processes, the case of practical interest, where a zero-order hold is part of the digital-to-analog converter, is considered. It is shown that the duality between the regulation and filtering problems is not conserved after discretization when an integrate-and-dump prefilter is used. Analysis of a specific model shows that the results obtained in the regulation problem are completely different from those obtained in the filtering problem.
ISA

**N91-20397** Tel-Aviv Univ. (Israel).
**HIGH POWER MILLIMETRIC WAVELENGTH SOURCES Ph.D. Thesis**
Itzhak Shraga Nov. 1989 249 p In HEBREW; ENGLISH summary
(ITN-91-85099) Copyright Avail: Tel-Aviv Univ., Exact Sciences Library, Ramat Aviv 69978, Israel

The aim was to develop powerful, millimetric-wavelength microwave sources, based on a free electron laser in which a dense relativistic electron beam interacts with a longitudinal magnetostatic wiggler. The theoretical background is presented for magnetically guided electron orbits, cyclotron resonance instability, and the Lowbitron-longitudinal wiggler. The electron beam was produced by a PI105 accelerator, which can accelerate 10-kA beams to 800 keV energy, in 10-nsec pulses. A cold foilless diode electron source was built, with a graphite cathode and variously shaped, interchangeable anodes, and the beam was guided along a stainless steel drift tube by a pulsed axial magnetic field. Onto a 30-kgauss field was superimposed a ripple, generated by a series of alternating insulating and conducting rings outside the drift tube. Electron beam and magnetic field parameters were measured, using a Faraday cup, witness plates and Rogowski coils, and the total generated microwave power, in the 60-140-GHz range, was measured with a broadband solid state detector or a calorimeter. Computer simulations and microwave measurements were used to establish the optimum electrode geometry for the foilless diode; a spherical graphite cathode and planar anode were chosen and a 1-kA pencil electron beam was extracted through an iris, centered on the longitudinal axis of the drift tube. Cyclotron instability studies showed that application of magnetic resonance criteria, in accordance with the theoretical model, enabled the maximum microwave power to be obtained. The 2nd harmonic of the cyclotron frequency was also found to agree well with the theoretical model. A 400-A, 740-kV, 4-mm diameter beam was used to investigate the Lowbitron-longitudinal wiggler free electron laser. A short, magnetoresonance-based, undulator was used to convert axial to perpendicular energy, and the beam was passed through the magnetostatic wiggler, implemented by magnetic diffusion. The microwave spectra were measured and analyzed for different wiggler periods and a modified dispersion equation for the cylindrical waveguide was solved numerically. Frequency and growth-rate solutions agreed well with the measurements.
ISA

**N91-20398#** Naval Research Lab., Washington, DC.
**SIMULATION STUDIES OF A KLYSTRONLIKE AMPLIFIER OPERATING IN THE 10 TO 100 GW REGIME**
J. Krall, M. Friedman, Y. Y. Lau, and V. Serlin 20 Nov. 1990 29 p
(AD-A229858; NRL-MR-6750) Avail: NTIS HC/MF A03 CSCL 20/7

A coaxial drift tube allows propagation of an ultra high power relativistic electron beam (500 keV, greater than or = 100 kA, 100 ns). The modulation covered of a large diameter (12.6 cm) intense relativistic electron beam (500 keV, 16 ka) by an external microwave source via particle simulation. The annular beam, enclosed within a coaxial drift tube, is found to be fully modulated by a low power external RF source at a frequency of 1.3 GHz. For such an intense beam, a highly nonlinear interaction takes place at the modulating gap, producing highly coherent bunches of electrons. This finding is similar to earlier research in which such modulation was studied for an intense beam propagating in a hollow drift tube. Unlike the hollow drift tube case, the coaxial configuration is easily scaled to high power. Here, a very large diameter (26 cm) intense beam (460 keV, 100 kA) is fully modulated at 1.3 GHz to obtain 31 GW of RF beam power. GRA

**N91-20399#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
**FLOATING GATE CIRCUITS IN MOSIS**
James R. Mann 1 Nov. 1990 51 p
(Contract F19628-90-C-0002)
(AD-A230154; TR-824; ESD-TR-90-114) Avail: NTIS HC/MF A04 CSCL 09/1

The MOSIS foundry offers a two-poly CMOS process that can be used as a floating gate technology, albeit not with the same performance as commercial EEPROM foundries. This report characterizes the structures and programming techniques necessary to build floating gate structures and associated high-voltage addressing circuitry on the low-noise analog process available through MOSIS. Techniques that are used include Fowler-Nordheim tunneling, channel hot-electron injection, and avalanche injection. The dielectric materials between the floating gate and both the control gate and substrate are characterized. Unconventional lightly doped drain FET devices and additional circuit techniques for handling the high-voltage programming signals are presented. Author (GRA)

**N91-20400#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**EVALUATION OF AN INTERDIGITATED GATE ELECTRODE FIELD-EFFECT TRANSISTOR FOR DETECTING ORGANOPHOSPHORUS COMPOUNDS M.S. Thesis**
Charles P. Brothers, Jr. Dec. 1990 247 p
(AD-A230161; AFIT/GE/ENG/90D-07) Avail: NTIS HC/MF A11 CSCL 17/8

This study used integrated circuit microsensors to detect organophosphorus compounds. Chemically-sensitive thin films, copper phthalocyanine, DFPase, succinyl chloride, succinylcholine chloride, 2-naphthol(B), and L-histidine dihydrochloride, were deposited on interdigitated gate electrode (IGE) structures, with an average thickness of 2000 A. Thin film electrical performance characteristics were measured for several parameters, including: dc resistance, ac impedance, time-domain, and spectral responses from 10 Hz to 1 MHz. Each microsensor contained nine IGEs; each IGE possessed an in situ field-effect transistor amplifier. After purging each sensor with filtered air, it was exposed to one or two of the following gases: diisopropyl fluorophosphate (DFP), diisopropyl methylphosphonate, and dimethyl methylphosphonate at concentrations spanning 100 ppb to 10 ppm (at 90 percent relative humidity and 23 C). Testing was conducted with microsensors heated to 30, 50, and 70 C. All six candidate films, demonstrated various degrees of sensitivity to the challenge gases at 30 C. DFPase was especially sensitive to the challenge gases at 100 ppb. Only copper phthalocyanine and L-histidine dihydrochloride demonstrated sensitivity above 30 C. In particular, 2-naphthol(beta) showed complete reversibility and succinyl chloride demonstrated partial reversibility at 30 C. Copper phthalocyanine was reversible only at 70 C. Succinylcholine chloride demonstrated a unique band-reject filter response to the presence of DFP in any challenge gas sample presented to the sensor. GRA

**N91-20401#** Office of the Under Secretary of Defense (Acquisitions), Washington, DC. Vhsic Program Office.
**VERY HIGH SPEED INTEGRATED CIRCUITS (VHSIC) Final Program Report, 1980 - 1990**
30 Sep. 1990 274 p
(AD-A230174) Avail: NTIS HC/MF A12 CSCL 09/1

This report presents a description and final account of the VHSIC program during its ten years of successfully developing advanced integrated circuit technologies and products for military systems. The new technologies and the products that VHSIC has produced have steadily found their way not only in defense systems but also into the commercial industrial base. They provide the reservoir from which new system capabilities are emerging and a foundation upon which continual further advances are being made. Over the course of the past decade, the VHSIC program has been active in the development of new materials, new circuit design concepts, advanced fabrication processes, new manufacturing equipment, higher levels of radiation harding, new data interface standards and specifications, and improved techniques for built-in-test maintainability. The VHSIC Hardware Description Language and other design automation tools have broken through major integrated circuit complexity barriers and will decrease the cost and development time of modern electronic systems. The resulting achievements have helped to produce a new level of system design and fabrication - one that approaches an integrated concept-to-system capability. GRA

**N91-20402#** Hypress, Inc., Elmsford, NY.
**SQUID AMPLIFIERS FOR INFRARED DETECTORS AND OTHER APPLICATIONS**
David Osterman 14 Dec. 1990 3 p
(Contract N00014-90-C-0227)
(AD-A230247) Avail: NTIS HC/MF A01 CSCL 20/10

The advantages of superconducting processing circuitry for focal plane arrays include low power consumption and the possibility of integrating processing circuitry and detectors on the same substrate. The latter configuration allows for reduction in the number of leads to the readout system; therefore, it removes a significant bottle neck in the processing of massive quantities of data coming from large IR FPAs. All signal processing steps may be executed with superconducting circuit elements. Amplification in superconducting circuitry is performed with the superconducting quantum interference device (SQUID) amplifier. The present phase 1 SBIR is being used to investigate a scheme for multiplexing many inputs into one SQUID amplifier. This will reduce the number of SQUID amplifiers needed which is a significant improvement because typical high-gain, multiturn-input SQUIDs are the largest element of superconductivity circuitry. The anticipated payoff of this research is in shrinking the size needed for superconducting circuitry that will be integrated onto IR FPA's. In addition, this method should add very little or no noise to the intrinsic detector noise; thus, avoiding any degradation in sensitivity when individual detectors are integrated into the array. GRA

**N91-20403#** Naval Postgraduate School, Monterey, CA.
**RECOGNITION OF VLSI MODULE ISOMORPHISM M.S. Thesis**
Emmanouil N. Zagourakis Mar. 1990 150 p
(AD-A230298) Avail: NTIS HC/MF A07 CSCL 09/1

The purpose of this study is to determine whether or not a program could be developed to examine isomorphism between parts of a very large scale integration (VLSI) layout. Many simulation files, obtained through Magic's hierarchical extractor, were analyzed in order to develop a C program to accomplish recognition in several types of gates. This recognition gives signatures in order to check for isomorphism. The development and design of the algorithms used in different parts of the program are described. Results demonstrate that recognition of elements in a CMOS circuit is possible, even with moderate complexity structures. An appendix with the C program listings is included. GRA

**N91-20404#** Wright Research Development Center, Wright-Patterson AFB, OH.
**A GENERALIZED EXTRACTION SYSTEM FOR VLSI Final Report, Jul. 1987 - Aug. 1990**
Michael A. Dukes, Frank Markham, and Joanne E. Degroat Oct. 1990 110 p
(AD-A230396; WRDC-TR-90-5021) Avail: NTIS HC/MF A06 CSCL 12/5

A Generalized Extraction System for VLSI (GES, pronounced guess) is described. GES, which is written in Prolog, performs logic extraction from transistor netlists, identification of logic errors within and between components, and generation of VHDL. The input to GES consists of a transistor netlist using format from extract in magic. Logic extraction has been performed, on transistor netlists extracted from design layouts in magic, up to the level of 32-bit adders and 32-bit registers. GES reports typical errors in the construction and interconnection of components. An error-report identifies the component and specifies its location within the magic layout, making it easy to locate the offending circuitry. GES also provides a hierarchical VHDL description of the layout-design that is verified to be free of a large class of design errors. GRA

**N91-20405#** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**THREE DIMENSIONAL TRANSIENT ANALYSIS OF MICROSTRIP CIRCUITS IN MULTILAYERED ANISOTROPIC MEDIA Annual Report, 1 Oct. 1989 - 30 Sep. 1990**
J. A. Kong Nov. 1990 16 p
(Contract N00014-90-J-1002)
(AD-A229691) Avail: NTIS HC/MF A03 CSCL 09/1

The propagation characteristics of signal lines with crossing strips in multilayered anisotropic media, a finite-difference time-domain method for single and coupled microstrip lines, the modelling of lossy microstrip lines with finite thickness, a hybrid method for the calculation of resistance and inductance of transmission lines with arbitrary cross section, an analysis of frequency-dependent complex systems with nonlinear terminations, input impedance of a probe-fed stacked circular microstrip antenna, and radiation from VLSI package configurations are discussed. GRA

**N91-20406*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**A SEVEN PATCH HEXAGONAL CP SUBARRAY WITH A CPW/STRIPLINE FEED NETWORK**
R. N. Simons, R. Q. Lee, and G. R. Lindamood (Akron Univ., OH.) 1991 11 p Prepared for presentation at the North American Radio Science Meeting and International IEEE/AP-S

Symposium, London, Ontario, 24-28 Jun. 1991
(Contract NAS3-25266)
(NASA-TM-103802; E-5927; NAS 1.15:103802) Avail: NTIS HC/MF A03 CSCL 09A

A seven element microstrip subarray of hexagonal geometry were designed and tested at S-band frequencies. The microstrip patch antenna is excited at a single feed position using a direct probe type connection to generate a circularly polarized wave. The RF power is coupled to these feed positions by a novel coplanar waveguide/stripline feeding network. The subarray architecture and the feed network are described in detail. The measured results include the feed network characterization as well as the radiation patterns of the subarray. Author

**N91-20407#** Syracuse Univ., NY. Dept. of Electrical and Computer Engineering.
**A PROCEDURE FOR NUMERICAL EVALUATION OF THE PERFORMANCE OF A TM01 CIRCULAR TO TE10 RECTANGULAR WAVEGUIDE MODE CONVERTER Final Report, 24 Oct. 1989 - 23 Oct. 1990**
Joseph R. Mautz and Roger F. Harrington Nov. 1990 98 p
(Contract DAAL02-88-K-0056)
(AD-A230445; SYRU/DECE/TR-90/3; HDL-CR-90-056-1) Avail: NTIS HC/MF A05 CSCL 09/1

Topics addressed include: The Admittance Matrices for the Rectangular Waveguides; The Admittance Matrix for the Circular Waveguide; The Excitation Vector; The Electric Field in the Rectangular Waveguides; The Electric Field in the Circular Waveguide; The Tangential Electric Field in the Apertures; Numerical Results; Ordering the Expansion Functions; and Roots of Bessel Functions and Their Derivatives. GRA

**N91-20408#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**SPECIFICATION AND EQUIVALENCE VERIFICATION OF SEQUENTIAL CIRCUITS VIA VHDL M.S. Thesis**
Richard L. Miller Nov. 1990 312 p
(AD-A230554; AFIT/GE/ENG/90D-41) Avail: NTIS HC/MF A14 CSCL 09/1

This research presents a merger of the specification and design capabilities of the Very High Speed Integrated Circuit (VHSIC) Hardware Description Language (VHDL) with a known verification method (UC Berkeley's verify software) in order to solve the design and verification problem of sequential circuits. The fruits of this research are a behavioral VHDL model for sequential circuit specification, a structural VHDL model for sequential circuit design, and a method for comparing two circuits described using these VHDL models in order to demonstrate circuit equivalence. The behavioral and structural VHDL models were developed and tested within the Intermetric's VHDL software support environment. Modifications were made to the existing UC Berkeley verify software so that it could accept sequential circuits described using the structural VHDL model. Additionally, a behavioral to structural VHDL translator (b2s) was developed such that sequential circuits expressed in the behavioral VHDL model could be shown equivalent to structural VHDL designs via the UC Berkeley verification software. GRA

**N91-20409#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**ADAPTIVE FILTERING AND SMOOTHING FOR TRACKING A HYPERSONIC AIRCRAFT FROM A SPACE PLATFORM M.S. Thesis**
Kenneth A. Gotski Dec. 1990 129 p
(AD-A230603; AFIT/GA/ENY/90D-6) Avail: NTIS HC/MF A07 CSCL 17/11

This study took a previously developed six state Kalman filter (designed for space-based tracking of a hypersonic transatmospheric vehicle), tuned it, and performed a Monte Carlo analysis. Three multiple model adaptive filters were then developed, with sub-filters designed for quiescent periods and periods with apparent acceleration. Next, a smoother was developed using the six state filter as the forward filter and a form of that same filter as the backward filter. The smoother and all of the above filters were compared for their ability to most accurately estimate the transatmospheric vehicle's state, with special emphasis on the acceleration states. This emphasis was motivated by a desire to evaluate the Kalman filter's usefulness as a real-time intelligence gathering tool. From the data generated, it was concluded that neither the adaptive filters nor the smoother improved upon the performance of the six state Kalman filter. GRA

**N91-20410#** University of Southern California, Los Angeles. School of Engineering.
**JOINT SERVICES ELECTRONICS PROGRAM RESEARCH IN ELECTRONICS Annual Technical Report, No. 3, 1 Jan. - 31 Dec. 1990**
William H. Steier 5 Jan. 1991 75 p
(Contract F49620-88-C-0067)
(AD-A230623) Avail: NTIS HC/MF A04 CSCL 20/12

The progress is documented which was made on the 13 research topics supported by the Joint Services Electronics Program. There are four research topics in solid state electronics, four in quantum electronics, and five in information electronics. GRA

**N91-20411#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**OPERATING CHARACTERISTICS OF XENON GAS DISCHARGES M.S. Thesis**
Michael E. Ruark Dec. 1990 103 p
(AD-A230660; AFIT/GEP/ENP/90D-06) Avail: NTIS HC/MF A06 CSCL 09/1

The voltage-current and spectral line intensity-current characteristics were measured for four Xenon gas discharges. The four discharge configurations were made up of two tubes, each examined at pressures of 1 and 10 Torr. The first tube was a hot filament tube with a 1 cm radius, and the second a cold cathode type tube of radius .3 cm. Intensity dependence upon current was primarily linear in all cases with some important deviations. The hot filament tube at 10 Torr showed a large decrease in intensity between 4 and 6 mA in the 8409 angstrom line. This is thought to be connected with the onset of constriction in the discharge at this point. The coincidence of the upper level of this transition with several molecular ion levels of xenon, could account for quenching of this transition. GRA

**N91-20412#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**DESIGN AND FABRICATION OF AN IMPLANTABLE CORTICAL SEMICONDUCTOR INTEGRATED CIRCUIT ELECTRODE ARRAY M.S. Thesis**
Pierre K. LeFevre Dec. 1990 90 p
(AD-A230676; AFIT/GE/ENG/90D-34) Avail: NTIS HC/MF A05 CSCL 09/1

This research furthered the processing steps of the AFIT 16 by 16 implantable cortical semiconductor integrated circuit electrode array, or brain chip. The areas of interest include the brain chip electronics, metallization, ionic permeation, and implantation. The electronics and metallization are heavily covered. A high speed, single clock divide-by-two circuit was modified with a reset transistor and cascaded to form a ripple counter. This device had stable operation at specific source voltage and clock voltage and frequency. A 7-stage inverter with 10 unmodified divide-by-two circuits cascaded operated between 1.7 and 8 volts, and between 39 KHz and 1 MHz, respectively. The metallization process refers to coating Au/Ni or Pt onto exposed aluminum areas (pads) of a CMOS integrated circuit. Sputtering was used to coat the chip. And an Au/Ni etchant or Pt peel-off technique was used. The Au/Ni etchant used was iodine, potassium iodide, and deionized water solution. GRA

**N91-20413#** Texas Univ., Austin. Electronics Research Center.
**JOINT SERVICES ELECTRONICS PROGRAM: ELECTRONICS RESEARCH AT THE UNIVERSITY OF TEXAS AT AUSTIN Annual Report No. 42, 1 Jan. - 31 Dec. 1990**

Edward J. Powers 31 Dec. 1990 125 p
(Contract F49620-89-C-0044)
(AD-A230805) Avail: NTIS HC/MF A06 CSCL 09/1

Scientific progress on Basic Research in Electronics which was conducted under the auspices of the DoD Joint Services Electronics program is summarized. Progress on five solid state, two information electronics, and two electromagnetic projects is described. GRA

**N91-20414#** Department of the Navy, Washington, DC.
**POWER TERMINAL PROTECTION DEVICE Patent Application**
Yung K. Yi, inventor (to Navy) 9 Oct. 1990 10 p
(AD-D014747; US-Patent-Appl-SN-594751) Avail: NTIS HC/MF A02 CSCL 10/2

Metal oxide varistors are connected in parallel with grounded capacitors to load outlet terminals coupled to a power source through inductor coils forming a low pass filter with the capacitors to delay propagation of a voltage increasing transient pulse to the power source until ground shunting paths of low resistance are developed in the varistors. Electromagnetic shielding partitions the inductor from the capacitors and varistors within a power outlet box mounting the load outlet terminals to prevent interference with absorption of transient energy by the varistors during the delayed ground shunting action. GRA

**N91-20415#** Lawrence Livermore National Lab., CA.
**PROGRESS TOWARD STEADY-STATE, HIGH-EFFICIENCY VIRCATORS**
P. Poulsen, P. A. Pincosy, and J. J. Morrison Dec. 1990 13 p Presented at the OE/LASE '91: 4th Society of Photo-Optical Instrumentation Engineers (SPIE) International Symposium, Los Angeles, CA, 20-25 Jan. 1991
(Contract W-7405-eng-48)
(DE91-008064; UCRL-JC-105613; CONF-910123-11) Avail: NTIS HC/MF A03

The resonance at which high-efficiency operation of virtual cathode oscillators is obtained occurs when the beam frequency equals the reflex frequency to within 2 percent. This tolerance limit in the frequency ratio implies that cathode closure in the anode-cathode gap is not acceptable. We have developed and tested a 6 sq cm cathode that will operate longer than 1 microsec at 300 A/sq cm without significant closure. As yet, the full-scale (greater than 80 sq cm) cathode has not worked quite as well. In many tests, the cathode will operate in the emission-limited temperature/field (T/F) mode for approximately 300 ns, and then transition into explosive emission with a relatively slow (approximately 0.5 cm/microsec) closure rate. The current density was 45 to 90 A/sq cm. We have not run high-power RF-emission tests under conditions where the diode stays open and in resonance for the duration of the RF pulse at a current density of 250 A/sq cm, which is required for 3 GHz operation; that test remains the focus of our continuing research. We have obtained long (600 ns) duration RF pulses at low power. We have also extended the data base on microwave generation at lower power and have shown that high-efficiency resonances will occur when a multiple of the reflex frequency equals the beam frequency. This allows greater flexibility in the design and scaling of the microwave device. DOE

**N91-20101*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**HIGH TEMPERATURE ELECTRONICS**
Gary T. Seng *In its* Aeropropulsion 1991 Mar. 1991 13 p
(For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 09C

# 34 FLUID MECHANICS AND HEAT TRANSFER

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics.*

**N91-20416*#** Illinois Univ., Urbana-Champaign. Center for Superconducting Research and Development.
**SOLUTION OF THE NAVIER-STOKES EQUATIONS FOR A DRIVEN CAVITY**
B. D. Semeraro and Ahmed Sameh 26 Mar. 1991 11 p
(Grant NAG3-1208)
(NASA-CR-188008; NAS 1.26:188008) Avail: NTIS HC/MF A03 CSCL 20D

The flow field in a lid driven cavity is determined by integration of the incompressible Navier-Stokes equations. The numerical integration is accomplished via an operator splitting method known as the theta-scheme. This splitting separates the problem into the solution of a quasi-stokes problem and a nonlinear convection problem. Some details of solution methods used for the two subproblems and results obtained for the driven cavity are described. The schemes developed for the quasi-Stokes problem are more advanced at this stage than those for the nonlinear problem. However, the approaches used for both parts are outlined. As a model problem, a two dimensional square cavity with sides of unit length and a lid moving with unit velocity from left to right is considered. The Navier-Stokes equations are discretized in space on a uniform staggered or MAC mesh. The time discretization is accomplished via the theta-scheme. Author

**N91-20417*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**A FINITE ELEMENT MODEL OF CONDUCTION, CONVECTION, AND PHASE CHANGE NEAR A SOLID/MELT INTERFACE**
**Ph.D. Thesis - Michigan Univ.**
Larry A. Viterna Jan. 1991 185 p
(NASA-TM-103721; E-5952; NAS 1.15:103721) Avail: NTIS HC/MF A09 CSCL 20D

Detailed understanding of heat transfer and fluid flow is required for many aerospace thermal systems. These systems often include phase change and operate over a range of accelerations or effective gravitational fields. An approach to analyzing such systems is presented which requires the simultaneous solution of the conservation laws of energy, momentum, and mass, as well as an equation of state. The variable property form of the governing equations are developed in two-dimensional Cartesian coordinates for a Newtonian fluid. A numerical procedure for solving the governing equations is presented and implemented in a computer program. The Galerkin form of the finite element method is used to solve the spatial variation of the field variables, along with the implicit Crank-Nicolson time marching algorithm. Quadratic Langrangian elements are used for the internal energy and the two components of velocity. Linear Lagrangian elements are used for the pressure. The location of the solid/liquid interface as well as the temperatures are determined form the calculated internal energy and pressure. This approach is quite general in that it can describe heat transfer without phase change, phase change with a sharp interface, and phase change without an interface. Analytical results from this model are compared to those of other researchers studying transient conduction, convection, and phase change and are found to be in good agreement. The numerical procedure presented requires significant computer resources, but this is not unusual when compared to similar studies by other researchers. Several methods are suggested to reduce the computational times. Author

**N91-20418*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**HYPERVELOCITY ATMOSPHERIC FLIGHT: REAL GAS FLOW FIELDS**

John T. Howe Nov. 1990 249 p
(NASA-RP-1249; A-90143; NAS 1.61:1249) Avail: NTIS HC/MF A11 CSCL 20D

Flight in the atmosphere is examined from the viewpoint of including real gas phenomena in the flow field about a vehicle flying at hypervelocity. That is to say, the flow field is subject not only to compressible phenomena, but is dominated by energetic phenomena. There are several significant features of such a flow field. Spatially, its composition can vary by both chemical and elemental species. The equations which describe the flow field include equations of state and mass, species, elemental, and electric charge continuity; momentum; and energy equations. These are nonlinear, coupled, partial differential equations that were reduced to a relatively compact set of equations of a self-consistent manner (which allows mass addition at the surface at a rate comparable to the free-stream mass flux). The equations and their inputs allow for transport of these quantities relative to the mass-averaged behavior of the flow field. Thus transport of mass by chemical, thermal, pressure, and forced diffusion; transport of momentum by viscosity; and transport of energy by conduction, chemical considerations, viscosity, and radiative transfer are included. The last of these complicate the set of equations by making the energy equation a partial integrodifferential equation. Each phenomenon is considered and represented mathematically by one or more developments. The coefficients which pertain are both thermodynamically and chemically dependent. Solutions of the equations are presented and discussed in considerable detail, with emphasis on severe energetic flow fields. For hypervelocity flight in low-density environments where gaseous reactions proceed at finite rates, chemical nonequilibrium is considered and some illustrations are presented. Finally, flight where the flow field may be out of equilibrium, both chemically and thermodynamically, is presented briefly. Author

**N91-20419*#** North Carolina State Univ., Raleigh. Dept. of Mechanical and Aerospace Engineering.
**NONEQUILIBRIUM RADIATIVE HEATING PREDICTION METHOD FOR AEROASSIST FLOWFIELDS WITH COUPLING TO FLOWFIELD SOLVERS Ph.D. Thesis**
Lin C. Hartung 1991 175 p
(NASA-CR-188112; NAS 1.26:188112) Avail: NTIS HC/MF A08 CSCL 20D

A method for predicting radiation adsorption and emission coefficients in thermochemical nonequilibrium flows is developed. The method is called the Langley optimized radiative nonequilibrium code (LORAN). It applies the smeared band approximation for molecular radiation to produce moderately detailed results and is intended to fill the gap between detailed but costly prediction methods and very fast but highly approximate methods. The optimization of the method to provide efficient solutions allowing coupling to flowfield solvers is discussed. Representative results are obtained and compared to previous nonequilibrium radiation methods, as well as to ground- and flight-measured data. Reasonable agreement is found in all cases. A multidimensional radiative transport method is also developed for axisymmetric flows. Its predictions for wall radiative flux are 20 to 25 percent lower than those of the tangent slab transport method, as expected, though additional investigation of the symmetry and outflow boundary conditions is indicated. The method was applied to the peak heating condition of the aeroassist flight experiment (AFE) trajectory, with results comparable to predictions from other methods. The LORAN method was also applied in conjunction with the computational fluid dynamics (CFD) code LAURA to study the sensitivity of the radiative heating prediction to various models used in nonequilibrium CFD. This study suggests that radiation measurements can provide diagnostic information about the detailed processes occurring in a nonequilibrium flowfield because radiation phenomena are very sensitive to these processes. Author

**N91-20420#** Oxford Univ. (England). Dept. of Engineering Science.
**EXPERIMENTAL TECHNIQUES IN UNSTEADY FLOWS**
M. L. G. Oldfield 1990 71 p Presented at VKI Lectures on Unsteady Aerodynamics, Rhode-Saint-Genese, Belgium, 18-22 Apr. 1988 Previously announced as N89-24279
(OUEL-1843/90; ETN-91-98954) Avail: NTIS HC/MF A04

Notes for four lectures intended as a practical user guide to some unsteady aerodynamic flow experimental measurement techniques are presented. Unsteady flows to be measured, including frequency and length scale, large scale unsteadiness, turbulence, boundary layer transition, shear layers and wakes, periodically time varying flows, shock waves and vortex flows, are explained. Wind tunnel requirements, intrusive measurements by hot wire and film anemometry and pressure probes, and surface measurements are described. Optical techniques covered include Schlieren photography, shadowgraph, holography, laser anemometry and flow tracing. Instrumentation and data acquisition and processing of unsteady data, using frequency analysis by fast Fourier transforms, convolution and correlation are described. ESA

**N91-20421#** Perugia Univ. (Italy).
**THE 11TH INTERNATIONAL SYMPOSIUM ON GAS KINETICS Abstracts Only**
F. Vecchiocattivi, comp. and F. Pirani, comp. 7 Sep. 1990 368 p Symposium held in Perugia, Italy, 2-7 Sep. 1990
(AD-A229885; R/D-6445-CH-01) Avail: NTIS HC/MF A16 CSCL 07/4

The abstracts are presented of the papers which were presented at the Symposium. The program includes contributions on new, as well as traditional, themes in Gas Phase Kinetics. Highlighted topics include: Atmospheric Chemistry; Theory of Reactive, Inelastic, and Photodissociative Processes; Combustion Chemistry; Elementary Reactions of Neutral and Ionic Species; Reaction Dynamics and State-to-State Chemistry; Photodissociation Dynamics; Gas-Surface Interactions. GRA

**N91-20422#** Mississippi State Univ., Mississippi State. Dept. of Mechanical and Nuclear Engineering.
**INVESTIGATIONS OF SURFACE ROUGHNESS EFFECTS ON TURBULENT FLOW AND HEAT TRANSFER Final Report, 15 May 1986 - 14 Sep. 1990**
Hugh W. Coleman, Robert P. Taylor, and M. H. Hosni Oct. 1990 270 p
(Grant AF-AFOSR-0178-86; AF Proj. 2307)
(AD-A229979; AFOSR-90-1173TR) Avail: NTIS HC/MF A12 CSCL 20/4

The primary objective was to investigate the effects of surface roughness on turbulent boundary layer heat transfer by obtaining accurate, comprehensive, quality heat transfer data for zero pressure gradient incompressible air flow over constant temperature test surfaces with well defined surface roughness geometries. Knowledge gained from the experimental investigation was used to improve and extend the roughness energy transport model used in the discrete element prediction method, thus enhancing and expanding the capability to predict the effects of surface roughness on turbulent flow and heat transfer. Fluid dynamics and heat transfer data for turbulent boundary layer flow over a smooth and five rough surfaces were taken in the Turbulent Heat Transfer Test Facility (THTTF) for x-Reynolds numbers ranging up to 10,000,000. The smooth wall data was used for qualification of the THTTF and provided base line data for comparison with the data from rough surfaces. GRA

**N91-20423#** National Center for Physical Acoustics, University, MS.
**AN EXPERIMENTAL INVESTIGATION OF ACOUSTIC CAVITATION IN GASEOUS LIQUIDS Technical Report, 1 Jan. - 31 Dec. 1990**
Dario F. Gaitan and Lawrence A. Crum 8 Nov. 1990 230 p
(Contract N00014-90-J-4021)
(AD-A230033; NCPA-LC-02-90) Avail: NTIS HC/MF A11 CSCL 20/1

High amplitude radial pulsations of a single bubble in several glycerine and water mixtures were observed in an acoustic

stationary wave system at acoustic pressure amplitudes on the order of 150 kPa at 21 to 25 kHz. Sonoluminescence, a phenomenon generally attributed to the high temperatures generated during the collapse of cavitation bubbles, was observed as short light pulses occurring once every acoustic period. These emissions could be seen to originate at the geometric center of the bubble when observed through a microscope. It was observed that the light emissions occurred simultaneously with the bubble collapse. Using a laser scattering technique, experimental radius-time curves were obtained which confirmed the absence of surface waves which are expected at pressure amplitudes above 100 kPa. From these radius-time curves, measurements of the pulsation amplitude, the timing of the major bubble collapse, and the number of rebounds were made and compared with several theories. The implications of this research on the current understanding of cavitation were discussed. GRA

**N91-20424#** Wyoming Univ., Laramie.
**ADAPTIVE COMPUTATIONS FOR PARTIAL DIFFERENTIAL EQUATIONS GOVERNING ADVECTIVE FLUID FLOWS Final Report, 1 May 1988 - 30 Sep. 1990**
Richard E. Ewing 27 Dec. 1990 12 p
(Contract N00014-88-K-0370)
(AD-A230179) Avail: NTIS HC/MF A03 CSCL 20/4

We developed improved approaches to the numerical simulation of highly advective fluid flows using adaptive computational schemes. (Applications include heat and mass transfer in flowing fluids, reaction-diffusion phenomena of combustion, bubbly and multiphase flows, underwater explosions, and electrochemistry). Solutions to the equations governing these flows commonly exhibit highly localized features--steep moving fronts, moving boundaries, unstable interfaces--not captured by standard numerical techniques with acceptable accuracy and computational cost. We developed adaptive techniques in which computational degrees of freedom are allocated according to qualitative properties of the equations being solved, to efficiently enhance local resolution. We focused on adaptive gridding methods implementing adaptive local gridding algorithms. Author (GRA)

**N91-20425#** Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
**NUMERICAL SIMULATION OF NONLINEAR RECEPTIVITY IN BOUNDARY LAYER TRANSITION Annual Report, 1 Oct. 1989 - 30 Sep. 1990**
Hermann F. Fasel 30 Sep. 1990 12 p
(Contract N00014-90-J-1274)
(AD-A230219) Avail: NTIS HC/MF A03 CSCL 20/4

The control of the transition from laminar to turbulent flow is of primary interest in many engineering applications. Delay or acceleration of transition to turbulent flow may enhance or restrain the fluid mixing, heat transfer or reduce the friction drag on aerodynamic bodies. This research considered two different approaches to influence the transition process. The first approach is based on the idea of changing the stability characteristics of the base flow. This approach we categorize as passive control. Examples of passive control include constant suction or blowing of fluid at the wall, favorable pressure gradient along the streamwise flow direction, or constant heating of the wall surface. The second approach to influence the transition process is termed active control. There the disturbance waves which are amplified because of the instability of the base flow are directly manipulated. The feasibility of this second approach and its potentially considerable advantages were demonstrated. In these experients, amplitude and phase controlled disturbances were produced by thin metal strips or actuators that were flush mounted on the surface of a flat plate. With proper phases and amplitudes, both naturally occurring and controlled (forced) Tollmien-Schlichting waves could be attenuated and thus the transition process delayed. GRA

**N91-20426#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**A COMPARISON OF MOLECULAR VIBRATION MODELING FOR THERMAL NONEQUILIBRIUM AIRFLOW M.S. Thesis**
Kenneth J. Moran Dec. 1990 102 p
(AD-A230356; AFIT/GAE/ENY/90D-17) Avail: NTIS HC/MF A06 CSCL 20/4

The effects of thermal nonequilibrium on flows about blunt-bodies have not been studied numerically in isolation from chemical reactions. Typically, air is modeled as a perfect gas or as a chemically reacting mixture. In the former case, significant errors result at Mach numbers exceeding about 5. However, below Mach numbers around 8, the effects of chemical reactions are negligible. This study analyzes flow about a simple axisymmetric blunt-body at moderate hypersonic speeds (Mach numbers between 5 to 8). A first-order-accurate Roe scheme was used to compute solutions of the Euler equations assuming different gas models: perfect gas, thermal equilibrium, and thermal nonequilibrium. Equilibrium and nonequilibrium shock standoff distances deviated 10 to 15 percent from perfect gas calculations. Nonequilibrium solutions produced striking temperature and density gradients in the stagnation region with a unique hot spot near the shock. GRA

**N91-20427#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**SKIN FRICTION AND HEAT TRANSFER PREDICTIONS FOR HYPERSONIC TURBULENT FLOW OVER AN OGIVE-CYLINDER M.S. Thesis**
Richard H. Byers Dec. 1990 137 p
(AD-A230496; AFIT/GAE/ENY/90D-4) Avail: NTIS HC/MF A07 CSCL 20/4

The WRDC/FIMG Parabolized Navier-Stokes (PNS) Code is used to numerically predict both laminar and turbulent hypersonic flows over an ogive-cylinder body at zero angle of attack. A parametric study is conducted to determine the effects of selected code input variables on heat transfer and skin friction predictions. Comparisons are made between the PNS predictions and experimental data from the WRDC/Mach 6 High Reynolds Number Test Facility. Various problems encountered while obtaining PNS starting and marching solutions and corrective steps taken are discussed. A mesh resolution study indicates the minimum radial grid density sufficient for obtaining reasonable heat transfer results. As expected, surface property characteristics are shown to be sensitive to the placement of the first radial grid point away from the surface. Predicted values for surface pressure ratios, local Stanton numbers and local skin friction coefficients are compared with experimental data along the body for laminar through fully developed turbulent flows. Good agreement between the predictions and the experimental data is shown for all flow conditions. GRA

**N91-20428#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**TURBULENCE SCALES IN THE PASSAGE OF A LINEAR TURBINE CASCADE**
James L. Acree Dec. 1990 193 p
(AD-A230521; AFIT/GAE/ENY/90D-1) Avail: NTIS HC/MF A09 CSCL 20/13

Convective heat transfer in a turbine cascade is examined for turbulence effects. Turbulence in the free stream is varied by injection of air through a jet-grid device upstream of the cascade. Pressure and flow patterns on the blade surface, and flow velocity in two components, are examined to determine the effect of the jet-grid. Velocity and velocity fluctuation in two components are measured. Local turbulence scales through the cascade passage are determined, and local turbulent energy dissipation rate is determined. Results indicate injection of air through the jet-grid changes the angle of incidence, and therefore changes the surface pressures and velocities on the blade. Heat transfer comparison is thereby invalidated. Variations in jet-grid plenum pressure change the turbulence microscale at the cascade entrance, but not the integral scale. Turbulence intensity is likewise relatively unaffected. Turbulence behavior in the passage indicates that velocity fluctuation and turbulence microscale are inversely related; turbulence intensity and microscale are not inversely related. With 6 percent freestream turbulence intensity, turbulence in the passage

center is influenced first by events near the suction surface, then by events near the pressure surface. The primary vehicle for cross-stream diffusion is increased cross-stream velocity component fluctuations. GRA

**N91-20429#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**ANALYSIS OF HYPERSONIC BLUNT-BODY FLOWS USING A TOTAL VARIATION DIMINISHING SCHEME AND THE MACCORMACK SCHEME M.S. Thesis**
Montgomery C. Hughson Dec. 1990 98 p
(AD-A230576; AFIT/GAE/ENY/90D-10) Avail: NTIS HC/MF A05 CSCL 20/4

An explicit second-order accurate, total variation diminishing (TVD) scheme and the MacCormack scheme are applied to the Euler equations in axisymmetric form to study hypersonic blunt body flows. The modified flux approach of Harten, with modification by Yee, for two-dimensional flows is extended to treat axisymmetric flows. Calculated flow properties for the steady state, blunt body problem such as shock standoff distance, bow shock shape, surface pressure distribution and entropy jump conditions are compared to theory, results from the MacCormack scheme, and experimental data for Mach numbers of 3.0, 4.03, 5.06, 6.03 and 8.1. Additionally, the TVD and MacCormack schemes are used to simulate numerically the unsteady shock impingement on a sphere. Results are compared to experimental data for a shock Mach number of 2.89. Analysis of the numerical simulations provide suitable ranges of values for the entropy correction parameter and the Courant (CFL) number. The high-resolution and robustness of the TVD scheme is clearly shown. GRA

**N91-20430#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**EFFECT OF RIBLETS ON PRESSURE RECOVERY IN A STRAIGHT-WALLED DIFFUSER M.S. Thesis**
Michael K. Reagan Dec. 1990 88 p
(AD-A230662; AFIT/GAE/ENY/90D-21) Avail: NTIS HC/MF A05 CSCL 20/4

The objective of this thesis was to investigate the effect of riblets on the pressure recovery in a straight-walled diffuser. Previous work has shown that riblets were effective in reducing the viscous drag over surfaces subjected to a turbulent boundary layer. More recently, riblets were shown to delay the flow separation within a subsonic, straight-walled diffuser by as much as 200 percent. The purpose of this investigation was to determine the effect on the pressure distribution within a diffuser that has had the flow separation point favorably altered by the application of riblets. Investigation results revealed that riblets not only delayed flow separation in a diffuser, but also altered the pressure distribution in a manner that allowed for improved recovery. This improvement was realized by an increase in the pressure coefficient of between 30 to 38 percent the larger increases occurring for those diffuser geometrics most likely leading to stall (high aspect ratio). Additionally, it was discovered that the introduction of static ports into the riblet surface did not significantly alter the flowfield over that of a geometrically similar riblet surface. GRA

**N91-20431#** RADEX, Inc., Bedford, MA.
**ONE-DIMENSIONAL ANALYSIS OF A RADIAL SOURCE FLOW OF WATER PARTICLES INTO A VACUUM Technical Report, Jan. - Aug. 1990**
A. Setayesh 31 Aug. 1990 45 p
(Contract F19628-89-C-0068)
(AD-A230729; RX-R-90081; GL-TR-90-0246; SR-4) Avail: NTIS HC/MF A03 CSCL 20/4

An analytical investigation is made of a one-dimensional radial source flow of water into a vacuum. The equations that describe this model are a sixth-order, nonlinear, two-point boundary value problem. The problem is solved by the shooting/splitting technique. The results of this investigation are compared with the other works in the literature and the comparisons generally are in good agreement. Engineering parameters for the release of water into space are used to give some indication of waterflow characteristics into a vacuum environment; these parameters were chosen to resemble those of a recent water release experiment from the space shuttle. GRA

**N91-20432#** Ecole Polytechnique Federale de Lausanne (Switzerland). Lab. de Recherches Hydrauliques.
**[ACTIVITIES REPORT OF THE LABORATORY FOR HYDRAULIC RESEARCH] Annual Report, 1989 [RAPPORT ANNUEL 1989, LABORATOIRE DE RECHERCHES HYDRAULIQUES]**
1990 155 p In ENGLISH and FRENCH
(ETN-91-98907) Avail: NTIS HC/MF A08

Research in hydrology is summarized. Velocity distribution in unsteady flow over gravel beds, steady gradually accelerating flow in a smooth open channel and decelerating flow in a gravel bed flume are discussed. A fully coupled unsteady mobile boundary flow model is described. Mathematical and numerical modeling of internal waves in Lake Geneva (Switzerland) is discussed. Seasonal mixing of temperature strata in Lake Geneva is given particular attention. For individual titles, see N91-20433 through N91-20439.

**N91-20433#** Ecole Polytechnique Federale de Lausanne (Switzerland).
**VELOCITY DISTRIBUTION IN UNSTEADY FLOW OVER GRAVEL-BEDS**
Haizhou Tu and Walter H. Graf *In its* Activities Report of the Laboratory for Hydraulic Research 1990 14 p (For primary document see N91-20432 12-34)
Avail: NTIS HC/MF A08

Velocity profiles are measured in a series of hydrographs over gravel beds. The following results are obtained: the velocity profiles follow the log law for most of the hydrographs investigated; the velocity profiles observing the log law are analyzed in light of the Br value and the II value. The Br value in unsteady flow depends on both the unsteadiness and the relative roughness and a loop exists between the Br value and the Froude Number. The relative water depth, where the local velocity is approximately equal to the vertically averaged velocity, cannot be assumed as a constant of 0.4 during the hydrographs investigated. ESA

**N91-20434#** Ecole Polytechnique Federale de Lausanne (Switzerland).
**STEADY GRADUALLY ACCELERATING FLOW IN A SMOOTH OPEN CHANNEL**
Walter H. Graf, Antonio H. Cardoso, and G. Gust *In its* Activities Report of the Laboratory for Hydraulic Research 1990 20 p In ENGLISH and FRENCH (For primary document see N91-20432 12-34)
Avail: NTIS HC/MF A08

The lack of quantitative results for flows over large scale bedforms and adverse channel slopes often encountered in fluvial hydraulics channel slopes is addressed. A study of steady gradually accelerating flow having a negative pressure gradient along the flow direction, achieved by installing an inclined plate on the bottom of a long and wide open channel, is described. Different flow discharges and bottom slopes are investigated and the influence of acceleration on the velocity profiles, turbulence intensity profiles and longitudinal evolution of the bottom shear stress is determined. Information from pressure gradient flows for boundary layers and pipes is used. ESA

**N91-20435#** Ecole Polytechnique Federale de Lausanne (Switzerland).
**DECELERATING FLOW IN A GRAVEL BED FLUME**
B. A. Kironoto and Walter H. Graf *In its* Activities Report of the Laboratory for Hydraulic Research 1990 14 p (For primary document see N91-20432 12-34)
Avail: NTIS HC/MF A08

The velocity and turbulence distributions of non uniform flow in a gravel bed flume subjected to defavorable pressure gradients (decelerating flow) are measured. It is found that self similarity is preserved over the entire depth. Rotta's conditions for equilibrium are approximately attained. Coles' law explains the mean velocity

data sufficiently well over the entire depth. Variation between speeds in open channel flow indicates a small difference with the one in pipe flows and in boundary layers. The turbulence intensity reaches its maximum of about 2.3 at y/D = 0.1 near the bottom. The turbulence intensity distribution is approximately self similar. Spectral measurements show that there is a region where the one dimensional spectrum function is proportional to f to the negative 5/3 power which indicates the existence of locally isotrope turbulence. ESA

**N91-20436#** Ecole Polytechnique Federale de Lausanne (Switzerland).
**FULLY COUPLED UNSTEADY MOBILE BOUNDARY FLOW MODEL (FCMOBED)**
Luis R. P. Correia, B. G. Krishnappan, and Walter H. Graf *In its* Activities Report of the Laboratory for Hydraulic Research 1990 12 p In ENGLISH and FRENCH (For primary document see N91-20432 12-34)
Avail: NTIS HC/MF A08

A fully coupled, one dimensional river model (FCMOBED) capable of predicting sediment transport and bed level changes under unsteady flow conditions is described. The governing equations for the mass and momentum balances of sediment water mixture under unsteady flow conditions in natural rivers with irregular geometries, are solved simultaneously using the Preissmann four point linear implicit scheme, with weighting factors for space and time coordinates. The resulting system of algebraic equations is solved using a new scheme of successive substitutions which allows the bridging of upstream and downstream boundary nodal values and the application of boundary and initial conditions to solve the unspecified boundary values. Knowing the complete solution for the boundary nodes, the interior nodal values are solved using this algebraic equation linking the adjacent nodes. A comparison between this solution procedure and the one based on a matrix generalization of the double sweep method is performed. The model is applied to the problem of sediment deposition upstream of a dam with an arbitrary sediment hydrograph at the upstream boundary and the results are compared with those of an uncoupled model. ESA

**N91-20437#** Ecole Polytechnique Federale de Lausanne (Switzerland).
**MATHEMATICAL AND NUMERICAL MODELING OF INTERNAL WAVES IN LAKE GENEVA (SWITZERLAND) Ph.D. Thesis**
Philippe Beckers *In its* Activities Report of the Laboratory for Hydraulic Research 1990 18 p (For primary document see N91-20432 12-34)
Avail: NTIS HC/MF A08

The temperature structure of the lake is approached using the concept of a two layer model. An unstationary and fully non linear two layer model taking the real topograhy as well as the Coriolis force into account, is developed. Different wind field distributions are applied at the lake surface. A semi implicit finite differences scheme was built to solve the hydrodynamic model and a least squares fit method for detection of periodicities in time series was used. Various campaigns of current and temperature measurements are executed to investigate lake responses and some reports of internal motions are given. Two types of internal wave motions emerge from data. ESA

**N91-20438#** Ecole Polytechnique Federale de Lausanne (Switzerland).
**STUDY OF SEASONAL VARIATION OF MIXING PHENOMENA IN THE HYPOLIMNION OF LAKE GENEVA (SWITZERLAND) [ETUDE DE LA VARIATION SAISONNIERE DES PHENOMENES DE MELANGE DANS L'HYPOLIMNION DU LEMAN]**
Ulrich Lemmin, Claude Perrinjaquet, and Walter H. Graf *In its* Activities Report of the Laboratory for Hydraulic Research 1990 18 p In FRENCH, ENGLISH summary (For primary document see N91-20432 12-34)
Avail: NTIS HC/MF A08

Temperature profiles taken at several stations at intervals of two weeks to one month indicate that during 1989, due to clement winter, deep water renewal of the Grand Lac has most likely not taken place. During the same time the intermediate layers gained in heat content, most importantly by the downward propagation of the 5.2 C isotherm to almost 200 m. Over the three study years, the lake shows a trend of heat gain. The gradient of heat content of the upper 80 m is stronger than in the layers below. The multiannual cycle of heat gain appears to be an important feature of Lake Geneva dynamics. ESA

**N91-20439#** Ecole Polytechnique Federale de Lausanne (Switzerland).
**HORIZONTAL TURBULENT MIXING DYNAMICS ON LARGE-SCALE AND FINE-SCALE IN LAKE GENEVA**
Zsolt Vecsernyes, Ulrich Lemmin, and Walter H. Graf *In its* Activities Report of the Laboratory for Hydraulic Research 1990 18 p In ENGLISH and FRENCH (For primary document see N91-20432 12-34)
Avail: NTIS HC/MF A08

Based upon measurements from the period of destratification of 1981 until the destratified one of the following year an investigation is carried out on turbulent mixing dynamics in Lake Geneva. High frequency current fluctuation components are determined for different ranges of decreasing lower limits by filtering the synoptic frequency field on the basis of kinetic energy spectra. The data is investigated by means of current rose analysis accomplishing a sensitivity analysis. They serve to calculate horizontal turbulent mixing coefficients; eddy viscosity, by the Ertel-Shtokman length scale method and eddy diffusion coefficients, by the integral time scale method. The evolution of the mixing coefficients related to the determined frequency ranges of the current fluctuations is studied. Their seasonal variation as well as that due to intense wind forcing are investigated. ESA

**N91-20440#** European Space Agency, Paris (France).
**THE INFLUENCE OF A MULTIPLE HOT-WIRE PROBE GEOMETRY ON THE RESULTS OF MEASUREMENTS IN TURBULENT FLOWS Ph.D. Thesis - Technische Univ.**
Henning Rosemann (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen, Germany, F.R. ) Nov. 1990 146 p Transl. into ENGLISH of Einfluss der Geometrie von Mehrfach-Hitzdrahtsonden auf die Messergebnisse in Turbulent Stroemungen (Goettingen, Fed. Republic of Germany, DLR), 1989 115 p Original language document was announced as N90-13724
(ESA-TT-1182; DLR-FB-89-26; ETN-91-98966) Avail: NTIS HC/MF A07; original German version available from DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany

An analytical evaluation method for calculating instantaneous velocity vectors from the signals of triple and quadruple hot wire probes of almost any geometry is presented. For various probe geometries, this can determine the range of incident angle within which there is an unambiguous association between the measurements and the velocity vector. In addition, some measurement errors arising in the time averaged velocity vector and the Reynolds stress tensor because of the limited spatial resolution capability of the probes are estimated theoretically and, in some cases, checked experimentally. On this point, a comparison between various three wire probes and a four wire probe of the Kovasznay type shows that turbulence measurements should be substantially more accurate with the latter. ESA

**N91-20441#** European Space Agency, Paris (France).
**GENERALISED SIMILARITY SOLUTIONS FOR THREE DIMENSIONAL, LAMINAR, STEADY COMPRESSIBLE BOUNDARY LAYER FLOWS ON SWEPT, PROFILED CYLINDERS**
Viktor Saljnikov and Uwe Dallmann (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen, Germany, F.R. ) Jan. 1991 119 p Transl. into ENGLISH of Verallgemeinerte Aehnlichkeitsloesungen fuer Dreidimensionale, Laminare, Stationaere, Kompressible Grenzschichstroemungen an Schiebenden Profilierte Zylindern (Goettingen, Fed. Republic of Germany, DLR) Original language document was announced as

N90-13725
(ESA-TT-1190; DLR-FB-89-34; ETN-91-98967) Avail: NTIS HC/MF A06; original German version available from DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 34.50 DM

Solutions for the laminar, steady, compressible, three dimensional boundary layer equations for flows over swept wings are derived using the method of generalized similarity. The model configuration is that of an infinitely long, swept, profiled cylinder in an ideal gas flow whose dynamic viscosity is a linear function of temperature. The pressure distribution, Pr (Prandtl) and Ma (Mach) numbers, as well as the angle of sweep (beta) and the temperature (T) boundary condition can be chosen arbitrarily. A universal mathematical model which can be integrated numerically is derived. With reference to transonic swept wings, the numerical calculations are performed for values in the vicinity of Pr = 0.72, Ma = 0.82, beta = 21 degrees, T(sub w)/T(sub 0) = 0.98 (isothermal wall). The influences of variations in Ma number, angle of sweep and wall temperature on the characteristic boundary layer properties between the stagnation point and the separation point are presented. ESA

**N91-20442#** Institut Franco-Allemand de Recherches, Saint-Louis (France).
**THE LASER-DOPPLER-VELOCIMETER FOR FLOW DIAGNOSTICS: DENSITY AND VELOCITY MEASUREMENTS IN POST-PISTON BOUNDARY LAYER FLOW**
F. Seiler, A. George, G. Mathieu, and G. Smeets 8 Jun. 1990 11 p Presented at the 5th International Symposium on Applications of Laser Techniques to Fluid Mechanics, Lisbon, Portugal, 9-12 Jul. 1989
(Contract BMVg-T/R-760/I-0014/I-1714)
(ISL-CO-208/90; ETN-91-98982) Avail: NTIS HC/MF A03

A novel application gas density determination, of the laser Doppler velocimeter usually applied for flow velocity measurements is described. The common use for flow velocity registration is described by means of experiments performed in a shock tube for obtaining information about the behavior of piston induced turbulent boundary layers. The velocity and density distributions behind a shock accelerated piston inside the turbulent boundary layer are investigated at different distances from the tube wall surface. A comparison is made of the experimental data with theoretical calculations. The experimentally determined boundary layer profiles are shown to be in good agreement with the theory applied for the piston boundary layer formation. ESA

**N91-20443#** Cranfield Inst. of Tech., Bedford (England). Coll. of Aeronautics.
**NUMERICAL COMPUTATION OF TWO-DIMENSIONAL UNSTEADY DETONATION WAVES IN HIGH ENERGY SOLIDS**
J. F. Clarke, S. Karni, J. J. Quirk, P. L. Roe, L. G. Simmonds, and E. F. Toro 1979 59 p Sponsored by Admiralty Weapons Establishment, Aldermaston, England
(Cranfield-Aero-9013; ISBN-1-871564-10-7; ETN-91-99016)
Avail: NTIS HC/MF A04; Cranfield Inst. of Technology, Coll. of Aeronautics, Cranfield, Bedford MK43 0 AL, England, HC 8 sterling pounds

Theoretical modeling of unsteady, 2-D detonation waves in high energy solids is addressed. A mathematical model and numerical method to solve the associated hyperbolic system of equations are presented. The models consist of the Euler equations augmented by extra conservation laws and source terms to account for chemical reaction and tracking of materials. Both the thermodynamics and the chemistry are treated in a simple way. Using a detonation analog due to Fickett, several numerical methods are tested and their performance in modeling the essential features of detonation waves is assessed. The numerical method selected for the full model is an extension of the conservative, shock capturing technique of Roe, together with an adaptive mesh refinement procedure that allows the resolution of fine features such as reaction zones. Results for some typical tests problems are presented. ESA

**N91-20444#** Lawrence Livermore National Lab., CA.
**PLANE STOKES FLOW DRIVEN BY CAPILLARITY ON THE FREE SURFACES OF A DOUBLY-CONNECTED REGION**
R. W. Hopper Jan. 1991 10 p
(Contract W-7405-eng-48)
(DE91-008627; UCRL-ID-105872) Avail: NTIS HC/MF A02

The free creeping viscous incompressible plant flow in a finite region, bounded by a simple smooth closed curve and driven solely by surface tension, was analyzed previously. The shape evolution was described in terms of a time-dependent mapping function. An equation giving the time evolution of the mapping, typically in parametric form, was derived. The theory is here extended to doubly-connected regions mapped from an annulus. It is found that the conjectured parametric map must satisfy three conditions. The elementary problem of the collapse of a concentric circular annulus is easily recovered, but no non-trivial flows have been discovered. The theory is used to show that confocal elliptic ring does not collapse through a sequence of confocal elliptic rings. DOE

**N91-20445*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**TURBULENT FLUID MOTION. PART 1: THE PHENOMENON OF FLUID TURBULENCE**
Robert G. Deissler Feb. 1991 19 p
(NASA-TM-103723; E-5956; NAS 1.15:103723) Avail: NTIS HC/MF A03 CSCL 20D

Some introductory material on fluid turbulence is presented. This includes discussions and illustrations of what turbulence is, and how, why, and where turbulence occurs. Author

**N91-20446*#** Institute for Computer Applications in Science and Engineering, Hampton, VA.
**ANALYSIS AND CONVERGENCE OF THE MAC SCHEME. PART 1: THE LINEAR PROBLEM Final Report**
R. A. Nicolaides (Carnegie-Mellon Univ., Pittsburgh, PA.) Mar. 1991 19 p Submitted for publication
(Contract NAS1-18605)
(NASA-CR-187536; ICASE-91-28; NAS 1.26:187536) Avail: NTIS HC/MF A03 CSCL 20D

The MAC discretization of fluid flow is analyzed for the stationary Stokes equations. It is proved that the discrete approximations do in fact converge to the exact solutions of the flow equations. Estimates using mesh dependent norms analogous to the standard H(sup 1) and L(sup 2) norms are given for the velocity and pressure, respectively. Author

**N91-20447*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**ADDITION OF EQUILIBRIUM AIR TO AN UPWIND NAVIER-STOKES CODE AND OTHER FIRST STEPS TOWARD A MORE GENERALIZED FLOW SOLVER**
Bruce S. Rosen (Grumman Aerospace Corp., Bethpage, NY.) Mar. 1991 51 p
(NASA-TM-102616; NAS 1.15:102616) Avail: NTIS HC/MF A04 CSCL 20D

An upwind three-dimensional volume Navier-Stokes code is modified to facilitate modeling of complex geometries and flow fields represented by proposed National Aerospace Plane concepts. Code enhancements include an equilibrium air model, a generalized equilibrium gas model and several schemes to simplify treatment of complex geometric configurations. The code is also restructured for inclusion of an arbitrary number of independent and dependent variables. This latter capability is intended for eventual use to incorporate nonequilibrium/chemistry gas models, more sophisticated turbulence and transition models, or other physical phenomena which will require inclusion of additional variables and/or governing equations. Comparisons of computed results with experimental data and results obtained using other methods are presented for code validation purposes. Good correlation is obtained for all of the test cases considered, indicating the success of the current effort. Author

**N91-20095*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**INTERNAL FLUID MECHANICS RESEARCH**
Lonnie Reid and Louis A. Povinelli *In its* Aeropropulsion 1991 Mar. 1991 3 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 20D

**N91-20096*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**INLETS, DUCTS, AND NOZZLES**
James R. Scott and John M. Abbott *In its* Aeropropulsion 1991 Mar. 1991 27 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 20D

**N91-20097*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**TURBOMACHINERY**
Anthony J. Strazisar, Raymond E. Gaugler, John J. Adamczyk, Dale J. Arpasi, and Isaac Lopez (Army Aviation Systems Command, Cleveland, OH.) *In its* Aeropropulsion 1991 Mar. 1991 8 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 20D

**N91-20098*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**CHEMICAL REACTING FLOWS**
Erwin A. Lezberg, Edward J. Mularz (Army Aviation Systems Command, Cleveland, OH.), and Meng-Sing Liou *In its* Aeropropulsion 1991 Mar. 1991 26 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 20D

# 35 INSTRUMENTATION AND PHOTOGRAPHY

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography.

For aerial photography see *43 Earth Resources and Remote Sensing.* For related information see also *06 Aircraft Instrumentation,* and *19 Spacecraft Instrumentation.*

**N91-20448#** Interior Dept., Washington, DC.
**DIGITAL ROUGHNESS GAUGE Patent Application**
M. H. McKeown, inventor (to Interior Dept.), S. C. Beason, inventor (to Interior Dept.), and T. Uppert, inventor (to Interior Dept.) 1 Aug. 1990 8 p
(PB91-119750; US-Patent-Appl-SN-561436) Avail: NTIS HC/MF A02 CSCL 14B

The invention relates to a digital roughness gage which can be used to digitize and/or trace the profile or roughness of natural surfaces, such as fractures or joint surfaces, or man-made surfaces, such as cavitation erosion or concrete finishes, when involved in geologic or engineering activities. GRA

**N91-20449#** Interior Dept., Washington, DC.
**GEOLOGICAL GYROCOMPASS Patent Application**
M. H. McKeown, inventor (Interior Dept.) and S. C. Beason, inventor (Interior Dept.) 24 Oct. 1990 10 p
(PB91-119743; US-Patent-Appl-SN-602598) Avail: NTIS HC/MF A02 CSCL 14B

The invention relates to a new and improved geologic mapping and surveying apparatus for providing accurate, dependable, and portable measurement of attitudes of planar surfaces in situations where magnetic compasses will not work. The invention provides a unique arrangement of the gyrocompass and power supply in a portable carrying case. A gyroscope is not dependent on the earth's magnetic field for a reference as is a magnetic compass. Therefore, the invention of a geological gyrocompass is immune to disturbances in the earth's magnetic field and nearly duplicates the Brunton compass accuracy but does not require an environment free of magnetic anomalies. GRA

**N91-20450*#** Old Dominion Univ., Norfolk, VA. Dept. of Electrical and Computer Engineering.
**NEW DEVICES FOR FLOW MEASUREMENTS: HOT FILM AND BURIAL WIRE SENSORS, INFRARED IMAGERY, LIQUID CRYSTAL, AND PIEZO-ELECTRIC MODEL Final Report, period ending 15 May 1990**
Griffith J. McRee, Jr. and A. Sidney Roberts, Jr. Feb. 1991 208 p
(Grant NAG1-735)
(NASA-CR-187911; NAS 1.26:187911) Avail: NTIS HC/MF A10 CSCL 14B

An experimental program aimed at identifying areas in low speed aerodynamic research where infrared imaging systems can make significant contributions is discussed. Implementing a new technique, a long electrically heated wire was placed across a laminar flow. By measuring the temperature distribution along the wire with the IR imaging camera, the flow behavior was identified. For individual titles, see N91-20451 through N91-20452.

**N91-20451*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**CONVECTIVE RESPONSE OF A WALL-MOUNTED HOT-FILM SENSOR IN A SHOCK TUBE**
A. Sidney Roberts, Jr., Kelly R. Ortgies, Ehud Gartenberg (Old Dominion Univ., Norfolk, VA.), and Debra L. Carraway *In* Old Dominion Univ., New Devices for Flow Measurements: Hot Film and Burial Wire Sensors, Infrared Imagery, Liquid Crystal, and Piezo-Electric Model Feb. 1991 6 p Submitted for publication (For primary document see N91-20450 12-35)
(Grant NAG1-735)
Avail: NTIS HC/MF A10 CSCL 14B

Shock tube experiments were performed in order to determine the response of a single hot-film element of a sensor array to transiently induced flow behind weak normal shock waves. The experiments attempt to isolate the response due only to the change in convective heat transfer at the hot-film surface mounted on the wall of the shock tube. The experiments are described, the results being correlated with transient boundary layer theory and compared with an independent set of experimental results. One of the findings indicates that the change in the air properties (temperature and pressure) precedes the air mass transport, causing an ambiguity in the sensor response to the development of the velocity boundary layer. Also, a transient, local heat transfer coefficient is formulated to be used as a forcing function in an hot-film instrument model and simulation which remains under investigation. Author

**N91-20452*#** Old Dominion Univ., Norfolk, VA.
**TWENTY-FIVE YEARS OF AERODYNAMIC RESEARCH WITH IR IMAGING: A SURVEY**
Ehud Gartenberg and A. Sidney Roberts, Jr. *In its* New Devices for Flow Measurements: Hot Film and Burial Wire Sensors, Infrared Imagery, Liquid Crystal, and Piezo-Electric Model Feb. 1991 20 p Presented at Thermosense 13: An International Conference on Thermal Applications and Image Diagnostic, Orlando, FL, 3-5 Apr. 1991 (For primary document see N91-20450 12-35)
(Contract NAS1-18584)
(SPIE-1467-59) Avail: NTIS HC/MF A10 CSCL 14B

Infrared imaging used in aerodynamic research evolved during the last 25 years into a rewarding experimental technique for investigation of body-flow viscous interactions, such as heat flux determination and boundary layer transition. The technique of infrared imaging matched well its capability to produce useful results, with the expansion of testing conditions in the entire spectrum of wind tunnels, from hypersonic high-enthalpy facilities to cryogenic transonic wind tunnels. With unique achievements credited to its past, the current trend suggests a change in attitude towards this technique: from the perception as an exotic, project-oriented tool, to the status of a routine experimental procedure. Author

**N91-20453*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**SOFTWARE MANUAL FOR OPERATING PARTICLE DISPLACEMENT TRACKING DATA ACQUISITION AND REDUCTION SYSTEM**
Mark P. Wernet Jan. 1991 44 p
(NASA-TM-103720; E-5951; NAS 1.15:103720) Avail: NTIS HC/MF A03 CSCL 09B

The software manual is presented. The necessary steps required to record, analyze, and reduce Particle Image Velocimetry (PIV) data using the Particle Displacement Tracking (PDT) technique are described. The new PDT system is an all electronic technique employing a CCD video camera and a large memory buffer frame-grabber board to record low velocity (less than or equal to 20 cm/s) flows. Using a simple encoding scheme, a time sequence of single exposure images are time coded into a single image and then processed to track particle displacements and determine 2-D velocity vectors. All the PDT data acquisition, analysis, and data reduction software is written to run on an 80386 PC. Author

**N91-20454#** Pennsylvania State Univ., University Park. Materials Research Lab.
**RELAXOR FERROELECTRICS FOR ELECTROSTRICTIVE TRANDUCERS Quarterly Report**
Dec. 1990 7 p
(Contract N00014-90-J-4077)
(AD-A229960) Avail: NTIS HC/MF A02 CSCL 09/1

The relaxor compositions proposed above are prepared by solid state reaction via the mixing/milling route. With all these compositions the B-site precursors are prepared first, then the appropriate amounts of PbO, TiO2, SrO, La2O3, K2O, etc. are added after precursor calcination. The component oxides selected offer ease of dispersability in aqueous solution and have minimal moisture absorption. GRA

**N91-20455#** JBS Technologies, Inc., Thousand Oaks, CA.
**VERSATILE HIGH PERFORMANCE HOLOGRAPHIC OPTICAL COATINGS Final Report, 7 Jun. - 30 Nov. 1990**
Jeffrey B. Shellan 15 Dec. 1990 120 p
(Contract N00014-90-C-0145)
(AD-A230090) Avail: NTIS HC/MF A06 CSCL 14/1

The potential for fabricating holographic coatings (HCs) with nearly arbitrary reflectivity profiles was investigated. The desire reflectivity spectrum of the HC could, for example, be the optimum matched filter for detecting a specified target against a bright high clutter background. Once the desired spectral profile of the filter was calculated using well known matched filter theory, holographic techniques would be used to produce the filter. The analysis presented has shown that such a procedure will work and allows the filter to be fabricated much more easily than would be the case for conventional multilayer dielectric coatings, deposited one layer at a time. Detailed analysis is presented for the case of HCs designed for the detection of missile plumes against an Earth background in the UV and visible spectral regions. GRA

**N91-20456#** California Inst. of Tech., Pasadena. Dept. of Electrical Engineering.
**DENSE MODIFIABLE INTERCONNECTIONS UTILIZING PHOTOREFRACTIVE VOLUME HOLOGRAMS Annual Technical Report, 1 Dec. 1989 - 30 Nov. 1990**
Demetri Psaltis and Yong Qiao 30 Nov. 1990 19 p
(Grant AF-AFOSR-0045-89; AF Proj. 2305)
(AD-A230164; AFOSR-90-1169TR) Avail: NTIS HC/MF A03 CSCL 04/1

This report describes an experimental two-layer optical neural network built at Caltech. The system uses photorefractive volume holograms to implement dense, modifiable synaptic interconnections and liquid crystal light valves (LCVS) to perform nonlinear thresholding operations. Kanerva's Sparse, Distributed Memory was implemented using this network and its ability to recognize handwritten character-alphabet (A-Z) has been demonstrated experimentally. According to Kanerva's model, the first layer has fixed, random weights of interconnections and the second layer is trained by sum-of-outer-products rule. After training, the recognition rates of the network on the training set (104 patterns) and test set (520 patterns) are 100 and 50 percent, respectively. GRA

**N91-20457*#** Georgia Inst. of Tech., Atlanta. School of Chemical Engineering.
**FREQUENCY RESPONSE OF A SUPPORTED THERMOCOUPLE WIRE: EFFECTS OF AXIAL CONDUCTION Progress Report, Oct. 1990 - Mar. 1991**
L. J. Forney, E. L. Meeks, and G. C. Fralick (National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.) Apr. 1991 58 p Sponsored in part by Arnold Engineering Development Center, Arnold AFB, TN
(Contract NCC3-135)
(NASA-CR-188069; E19-666-2; NAS 1.26:188069) Avail: NTIS HC/MF A04 CSCL 14B

Theoretical expressions are derived for the steady-state frequency response of a supported thermocouple wire. In particular, the effects of axial heat conduction are demonstrated for both a supported one material wire and a two material wire with unequal material properties across the junction. For the case of a one material supported wire, an exact solution is derived which compares favorably with an approximate expression that only matches temperatures at the support junction. Moreover, for the case of a two material supported wire, an analytical expression is derived that closely correlates numerical results. Experimental data were taken with a type K supported thermocouple. The test thermocouple was constructed with dimensions to demonstrate the effects of axial heat conduction assuming constant physical properties across the junction. Author

**N91-20458#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**COMPUTER GENERATED HOLOGRAPHY AS A THREE-DIMENSIONAL DISPLAY MEDIUM M.S. Thesis**
Bryant L. Stuart Dec. 1990 78 p
(AD-A230583; AFIT/GCS/ENG/90D-14) Avail: NTIS HC/MF A05 CSCL 14/1

A process was developed to produce three dimensional images using computer generated holography (CGH). This process consisted of a series of steps that began with a geometric description of an object and concluded with a three dimensional holographic image being computed from a synthetic wavefront. The objects used in this series of steps (or CGH pipeline) were described geometrically as a collection of three dimensional points. The modular nature of the CGH pipeline provided a flexible platform from which to evaluate various object geometries, interference calculations algorithms, and interference pattern recording and reduction techniques. This system was implemented with general purpose computer workstations to compute the interference patterns, a postscript laser printer to record the patterns, and standard photographic reduction techniques to generate transmission holograms. Optical density filters were used to allow a hologram's virtual image to be safely viewed through the transmission hologram down the bore of the laser. The hologram's real image was observed as a collection of the object's planes captured on a white card. The reference beam was modeled as a plane wave normal to the recording surface with a constant phase angle of zero radians at all locations of the recording surface. The major constraint of this system was the limited spatial resolution of the laser printer which limited the geometric placement of the objects to be recorded. GRA

**N91-20459#** Rome Univ. (Italy). Dipt. di Fisica.
**THE UA1 URANIUM/WARM LIQUID CALORIMETER: CALIBRATION, STUDY OF THE ENERGY RESPONSE AND OF COMPENSATION**
F. Cavanna and S. Veneziano (Istituto Nazionale di Fisica Nucleare, Rome, Italy ) 4 Jun. 1990 58 p Presented at 75th Italian

Society of Physics National Congress, Cagliari, Italy, 29 Sep. 1989
(Nota-Interna-950; ETN-91-98872) Avail: NTIS HC/MF A04

The construction techniques used in making the uranium/TMP (Tetra Methyl Penthane) calorimeter are described. Test beam results of the first full size models built for the UA1 experiment at the CERN p-pbar collider are presented. The operating principles of calorimetry based on ionization chambers filled with organic liquids at room temperature are reviewed. Methods of monitoring the electron lifetime are discussed. Results of experiments on the response of the calorimeter to electrons and hadrons with a momentum of 1 to 70 GeV/c are presented and the possibility of tuning the e/pi ratio with the electric field is discussed. ESA

**N91-20460#** Rome Univ. (Italy). Dipt. di Fisica.
**PERFORMANCES OF A RESISTIVE PLATE COUNTER AT HIGH IONIZATION RATES**
M. Iori and F. Massa (Istituto Nazionale di Fisica Nucleare, Rome, Italy ) 26 Sep. 1990 22 p Submitted for publication
(Nota-Interna-960; ETN-91-98881) Avail: NTIS HC/MF A03

The efficiency and the time resolution of a 1 by 2 meter Resistive Plate Counter (RPC) are studied at the IMW TRIGA nuclear reactor. The whole surface of the detector is exposed to a beam of gamma rays inducing a counter rate up to approximately 150 kHz. The results are compared with a previous test performed with a pion beam. The main difference in the experimental conditions of the tests is concluded to be due to the total ionization rate of the RPC. ESA

**N91-20461#** Ecole Nationale Superieure des Telecommunications, Paris (France).
**POINT OF SHOT RECOGNITION FOR A PHOTOGRAPH FROM A MODEL OF THE SCENE Ph.D. Thesis [RECONNAISSANCE DU POINT DE PRISE DE VUE D'UNE PHOTOGRAPHIE A PARTIR D'UN MODELE DE SCENE]**
Evelyne Lutton 1990 212 p In FRENCH Sponsored by Direction des Recherches, Etudes et Techniques, France
(TELECOM-90-E-005; ISSN-0751-1353; ETN-91-98900) Avail: NTIS HC/MF A10

The problems involved in point of shot recognition are discussed. The steps required in such a recognition process are outlined. The images used over the course of the research are presented and analyzed. A system allowing for location of a camera to be obtained through analysis of a single photograph is presented. A representation and data storage model is developed. An image analysis task sequence is outlined. The technique is based on extrapolation of perspective lines with estimation of rotation carried out using image segments. ESA

**N91-20462** National Physical Lab., Teddington (England). Div. of Electrical Science.
**THE DEVELOPMENT OF AN UNTUNED CAVITY AS A HIGH EFFECTIVE TEMPERATURE MICROWAVE CALIBRATION SOURCE**
P. B. Whibberley, P. G. Quincey, J. R. Birch, and D. V. Bartlett Aug. 1990 110 p
(NPL-DES-106; ISSN-0143-7305; ETN-91-99027) Copyright Avail: National Physical Lab., Teddington, Middlesex, TW11 0LW, England

The development and characterization of an untuned cavity as a microwave source of high effective radiometric temperature are described. This source is intended for use in the calibration of the Fabry-Perot spectrometers forming part of the Electron Cyclotron Emission (ECE) diagnostic system on the Joint European Torus (JET). Radiation input to the cavity is provided by backward wave oscillators operating between 100 and 170 GHz at a typical bandwidth of 0.5 GHz. The cavity is shown to give an isotropic output which simulates that from a black body source observed with a bandwidth smaller than the resolution of the spectrometer. ESA

**N91-20463#** Westinghouse Idaho Nuclear Co., Inc., Idaho Falls.
**TWO-PART-LIQUID-MIXTURE PERCENTAGE MEASUREMENT USING A FLOW-THROUGH CAPACITANCE SENSOR**
T. C. Piper Jan. 1991 13 p
(Contract DE-AC07-84ID-12435)
(DE91-007584; WINCO-1081) Avail: NTIS HC/MF A03

A flow-through capacitance sensor with application-specific electronics that includes auto-calibration and fail-safe circuitry has been built and tested to measure the percentage of tributyl phosphate (TBP) in n-dodecane. The system has been tested with the flow-through sensor at 100 foot distance from the electronics and shows no sensitivity to cable movement. The calibration data fits a second degree polynomial well. DOE

**N91-20464#** Argonne National Lab., IL.
**LARGE APERTURE CCD X RAY DETECTOR FOR PROTEIN CRYSTALLOGRAPHY USING A FIBEROPTIC TAPER**
M. G. Strauss, E. M. Westbrook, I. Naday, T. A. Coleman, M. L. Westbrook, D. J. Travis, R. M. Sweet, and J. W. Pflugrath (Cold Spring Harbor Lab., New York, NY.) 1991 16 p Presented at the Society of Photo-optical Instrumentation Engineers (SPIE) Symposium on Electronic Imaging Science and Technology, San Jose, CA, 25 Feb. - 1 Mar. 1991
(Contract W-31-109-eng-38)
(DE91-008832; ANL/CP-71633; CONF-910294-1) Avail: NTIS HC/MF A03

A detector with a 114 mm aperture, based on a charge-coupled device (CCD), has been designed for x-ray diffraction studies in protein crystallography. The detector was tested on a beamline of the National Synchrotron Light Source at Brookhaven National Laboratory with a beam intensity greater than 10(exp 9) x-ray photons/s. A fiberoptic taper, an image intensifier and a lens demagnify, intensify, and focus the image onto a CCD having 512 x 512 pixels. A detective quantum efficiency (DOE) of 0.36 was obtained by evaluating the statistical uncertainty in the detector output. The dynamic range of a 4 x 4 pixel resolution element, comparable in size to a diffraction peak, was 10(exp 4). The point-spread function shows FWHM resolution of approximately 1 pixel, where a pixel on the detector face is 160 microns. A complete data set, consisting of forty-five 1 deg rotation frames, was obtained in just 36 s of x-ray exposure to a crystal of chicken egg-white lysozyme. In a separate experiment, a lysozyme data set consisting of 495 0.1 deg frames, was processed by the MADNES data reduction program, yielding symmetry R-factors for the data of 3.2 to 3.5 percent. Diffraction images from crystals of the myosin S1 head (a = 275 A) were also recorded. The Bragg spots, only 5 pixels apart, were resolved but were not sufficiently separated to process these data. Changes in the detector design which will improve the DOE and spatial resolution are outlined. The overall performance showed that this type of detector is well suited for x-ray scattering investigations with synchrotron sources. DOE

**N91-20465*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**SPECTROPHOTOMETER-INTEGRATING-SPHERE SYSTEM FOR COMPUTING SOLAR ABSORPTANCE**
William G. Witte, Jr., Wayne S. Slemp, and John E. Perry, Jr. (Continuous Electron Beam Accelerator Facility, Newport New, VA.) Washington Apr. 1991 23 p
(NASA-TM-4252; L-16815; NAS 1.15:4252) Avail: NTIS HC/MF A03 CSCL 14B

A commercially available ultraviolet, visible, near-infrared spectrophotometer was modified to utilize an 8-inch-diameter modified Edwards-type integrated sphere. Software was written so that the reflectance spectra could be used to obtain solar absorptance values of 1-inch-diameter specimens. A descriptions of the system, spectral reflectance, and software for calculation of solar absorptance from reflectance data are presented.
Author

**N91-20100*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**PROPULSION INSTRUMENTATION RESEARCH**

William C. Nieberding, Daniel J. Lesco, and W. Dan Williams *In its* Aeropropulsion 1991 Mar. 1991 21 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 14B

**N91-20709*#** South Dakota Univ., Vermillion. Human Factors Lab.
**ENHANCING THE USABILITY OF CRT DISPLAYS IN TEST FLIGHT MONITORING**
Michael M. Granaas and Victoria E. Sredinski *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 529-534 (For primary document see N91-20702 12-59)
(Grant NAG2-492)
Avail: NTIS HC/MF A14 CSCL 14B

# 36 LASERS AND MASERS

Includes parametric amplifiers.
For related information see also *76 Solid-State Physics.*

**N91-20466#** Naval Research Lab., Washington, DC.
**ELIMINATION OF LASER PREPULSE BY RELATIVISTIC GUIDING IN A PLASMA**
P. Sprangle, A. Zigler, and E. Esarey 27 Nov. 1990 14 p Prepared in cooperation with FM Technologies, Inc., Fairfax, VA
(AD-A229859; NRL-MR-6751) Avail: NTIS HC/MF A03 CSCL 09/3

A method is proposed for eliminating prepulses associated with high power, ultrashort laser pulses. In this method the high power portion of the pulse is refractively guided due to relativistic effects associated with the plasma electrons. The low power prepulse, however, is unaffected by the plasma and diffracts away. Optical guiding is achieved by appropriately choosing the plasma density, laser power and wavelength. In addition, a wavebreaking stabilization mechanism for the Raman backscattering instability for intense laser pulses is proposed. This stabilization mechanism indicates that the intense laser pulse should not be significantly backscattered by the plasma. GRA

**N91-20467#** Naval Research Lab., Washington, DC.
**KEY PHYSICS ISSUES AFFECTING THE PERFORMANCE OF FREE ELECTRON LASERS Interim Report**
C. M. Tang, B. Hafizi, E. Esarey, A. Ting, and W. Marable 20 Dec. 1990 48 p
(AD-A229992; NRL-6754) Avail: NTIS HC/MF A03 CSCL 09/3

Free electron lasers (FELs) are currently under intense research and development throughout the world for a variety of applications. A number of physics issues place limits on the performance of FELs. These include, among others: (1) the generation of high quality, high current electron beams, (2) optical guiding of the generated radiation beam, (3) undulator field errors, and (4) the excitation of sideband radiation. The goal is to review and discuss these FEL physics issues. The most important component of an FEL is a high quality electron beam. For efficient operation the effective electron beam energy spread must be sufficiently small. The effective energy spread is determined by: (1) transverse beam emittance, (2) undulator transverse spatial gradients, (3) undulator field error effects, (4) beam space charge effects, (5) intrinsic energy spread, and (6) energy stability. Another important aspect of FEL operation is optical guiding of the generated radiation beam. In many proposed FEL experiments, the short wavelength radiation beam will not be confined by a waveguide structure, and the interaction length is required to be long compared to the free-space Rayleigh (diffraction) length. Optical guiding of the generated radiation can, therefore, play a central role in the practical utilization of FELs. However, optical guiding imposes limits on several FEL parameters. These, as well as other constraints, are discussed in detail. GRA

**N91-20468#** Aerospace Corp., El Segundo, CA. Lab. Operations.
**DEGENERATE FOUR-WAVE MIXING OF CW HF LASER BEAMS IN HF ABSORPTION CELL**
Harold Mirels, John G. Coffer, Jay M. Bernard, and Richard A. Chodzko 6 Aug. 1990 54 p
(AD-A230183; TR-0089(4930-06)-3; SSD-TR-90-29) Avail: NTIS HC/MF A04 CSCL 09/3

Phase conjugation of a CW hydrogen fluoride (HF) laser beam has been investigated experimentally and theoretically using resonant degenerate four-wave mixing (DFWM) in an HF gas absorption cell. A single-line single-mode HF laser, operating on P1(8), P1(9) or P1(10) transitions, provided total (forward plus backward) pump beam intensities of 130, 600, and 400 W/sq cm, respectively, in the HF absorption cell. A probe beam intensity of the order of 10 W/sq cm was also provided. Conjugate reflection of the probe beam was investigated as a function of gas cell pressure and as a function of frequency detuning from line center. The variation of reflectivity with gas cell pressure at fixed laser beam intensity indicated a peak reflectivity of the order of .0001 at pressures from 2 to 4 Torr. Measurement of conjugate beam intensity, as a function of frequency detuning from the line center, provided a signal with a full width at half maximum (FWHM) of about 30 MHz. The latter is of the order of the homogeneous width, for HF at the test pressure, and may be compared to the Doppler width delta nu sub d = 300 MHz for the medium. An Analytical model is presented which provides theoretical estimates for the variation of reflectivity with pressure. Effects of diffusion, thermal conduction, pump depletion, and a nonuniform (Gaussian) profile are considered. Theoretical estimates for peak reflectivity agree with experiments to within a factor of about 2. GRA

**N91-20469#** Aerospace Corp., El Segundo, CA. Lab. Operations.
**BiF/NF2 KINETICS STUDIES. MECHANSIM AND CONVERSION EFFICIENCY**
R. F. Heidner, III, J. S. Holloway, and J. B. Koffend 31 Aug. 1990 39 p
(Contract F04701-88-C-0089)
(AD-A230222; TR-0090(5604)-1; SSD-TR-90-34) Avail: NTIS HC/MF A03 CSCL 07/4

Unraveling the complex kinetics of the Nitrogen fluoride energy transfer system has been an ongoing concern of the laboratory for the past several years. The system is of particular interest because of its potential as a visible chemical laser. Of central importance in the evaluation of this potential is a knowledge of the chemical pathways leading to the formation of electronically excited Bismuth fluoride. The results are described of a series of recent experiments designed to investigate the nature of the BiF production mechanism and the efficiency with which the electronic energy of NF is converted to BiF(A-X) photons. The time behavior was examined of three key species resulting from excimer laser initiated reactions of NF2/Bi(CH3)3, NF2/Bi(CH3)3/H2, and NF2/Bi(CH3)3/HBr mixtures. GRA

**N91-20470#** Rhode Island Univ., Kingston. Dept. of Electrical Engineering.
**EXTERNAL CAVITY COHERENT TRANSMITTER MODULES Final Report, Oct. 1987 - Sep. 1988**
Harish Sunak Nov. 1990 220 p
(Contract F30602-81-C-0193)
(AD-A230239; RADC-TR-90-100) Avail: NTIS HC/MF A10 CSCL 09/3

This report covers work done with a Fabry-Perot semiconductor laser based external cavity structure, for use with coherent fiber optical communications systems. A novel structure was developed which uses a single-mode fiber as part of the external cavity, together with a graded-index rod lens and a diffraction grating end reflector. The advantages of choosing this structure are highlighted, the principal being that it can be used with any modulation format, at any bit rate and also as the transmitter laser or the local oscillator laser. The latter has to have wide tunability so that the coherent receiver can select closely packed

optical channels, and the structure selected is the only one that offers very wide turnability of over 100nm or 12,000 GHz. Various measurements done with this structure are included in this report. Extensive theoretical work an spectral linewidth and tunability is also reported and detailed comparison of the above structure is made with those based on distributed feedback lasers and also having external cavities. Author (GRA)

**N91-20471#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**CHARACTERIZATION OF AgGaSe2 AND ZnGeP2 FOR FREQUENCY DOUBLING CO2 LASER OUTPUT M.S. Thesis**
Monte D. Turner Sep. 1990 141 p
(AD-A230354; AFIT/GEP/ENP/90D-10) Avail: NTIS HC/MF A07 CSCL 20/6

This experiment was to characterize the nonlinear performance of AgGaSe2 and ZnGeP2 for frequency doubling CO2 laser output at 10.6 um. The experiments included a series of theoretical estimates of the source and crystal performance to define the measurements to be performed. The parameters of interest were the phase matching angles, angular acceptance, conversion efficiency and damage thresholds. The 9 x 9 x 29 mm antireflection coated sample of AgGaSe2, with a phase matching angle of theta = 55.02 deg. and an internal acceptance bandwidth Delta theta = 0.298 deg., achieved a maximum second harmonic conversion efficiency of 20.5 percent. Surface damage limited the improvement of the efficiency and the threshold for the coated surface was near 4.5 kW/cm. Further damage studies were conducted using small witness samples from the same crystal boule. For the case of the uncoated sample of ZnGeP2, the theoretical computations pointed out that the performance would have been poor at best due to an extremely small effective nonlinear coefficient at the temperature tuned phase matching angles. These calculations are presented, though no output at 5.3 um was observed during these experiments. Improvements to the experimental designs and theoretical estimates are cited for continued work with both of these crystals. GRA

**N91-20472*#** American Univ., Washington, DC. Dept. of Physics.
**DESIGN OF A HIGH-GAIN LASER DIODE-ARRAY PUMPED Nd:YAG ALTERNATING PRECESSIVE SLAB AMPLIFIER (APS-AMPLIFIER)**
D. Barry Coyle 1991 23 p
(Grant NsG-50333)
(NASA-CR-183476; NAS 1.26:183476) Avail: NTIS HC/MF A03 CSCL 20E

In the design of space qualifiable laser systems for ranging and altimetry, such as NASA's Geodynamic Laser Ranging System (GLRS), the transmitter must be kept small, powerful yet efficient, and must consist of as few components as possible. A novel preamplifier design is examined which requires no external beam steering optics, yielding a compact component with simple alignment procedures. The gains achieved are comparable to multipass zigzag amplifiers using two or more sets of external optics for extra passes through the amplifying medium. Author

**N91-20473#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**EFFECTS OF SPECIFIC HEAT RATIO ON A SIMULATED CHEMICAL LASER CAVITY FLOW M.S. Thesis**
Curt D. Botts Dec. 1990 104 p
(AD-A230459; AFIT/GAE/ENY/90D-3) Avail: NTIS HC/MF A06 CSCL 09/3

Mixing of primary cold flow air and secondary helium to control the ratio of specific heats for the medium flowing through a simulated chemical laser nozzle/lasing cavity was accomplished. The effects of a range of mixture specific heat ratios on flowfield behavior were examined using static pressure ports in the test cavity. Schlieren photography and high speed filming aided description of the flow dynamics. Results indicated that boundary layer effects became evident in the nozzles as specific heat ratios increased. Large pressure fluctuations were observed in the cavity when helium was introduced into the flow to raise the specific heat ratio. This unstable behavior was attributed to the helium mass flow into the mixer and the mixer design itself. Use of the air/helium mixer brought about the pressure fluctuations earlier in a test run than with the mixer removed under the same conditions. Favorable pressure conditions for lasing were achieved for at least two seconds for the supersonic nozzles' design specific heat ratio of 1.51. Adverse pressure behavior was also attributed to three dimensional viscous effects along the cavity walls. GRA

**N91-20474#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**CONTINUOUS WAVE AND PULSED SOLID STATE LASER MODEL M.S. Thesis**
Matthew D. Rotondaro Nov. 1990 77 p
(AD-A230513; AFIT/GEP/ENP/90D-5) Avail: NTIS HC/MF A05 CSCL 09/3

A solid state laser is modeled for use on a personal computer. The model can accurately represent Nd:YAG and Nd:Glass lasers during both continuous wave and repetitively pulsed operation. The large number of input variables allow the user to make changes to the cavity, optical pump source, and the cooling system. The model calculates the energy, power, and divergence angle of the beam along with other variables. Because of its user-friendly interface, it is possible for someone with limited laser experience to obtain useful information. GRA

**N91-20475#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**A COMPUTER MODEL OF A CO2 OSCILLATOR-AMPLIFIER SYSTEM M.S. Thesis**
William F. Anderson Dec. 1990 87 p
(AD-A230597; AFIT/GSO/ENP/90D-01) Avail: NTIS HC/MF A05 CSCL 09/3

An existing CO2 laser amplifier simulation model developed for use on IBM-compatible personal computers has been improved through the redesign and addition of supplemental procedures from several models. The models and selected procedures which form the basis of the improved model are described. One procedure calculates the pumping rates of CO2 and N2 through calculation of the Boltzmann equation. Another procedure calculates the average vibrational temperatures of C2's vibrational modes. A third procedure replaces the Runge-Kutta integrator used in the original model with a faster, more accurate Adams-Bashforth-Moulton predictor-corrector integrator. GRA

**N91-20476#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**AN OPTICALLY PUMPED MOLECULAR BROMINE LASER M.S. Thesis**
Jon W. Morrison Dec. 1990 100 p
(AD-A230677; AFIT/GEO/ENP/90D-3) Avail: NTIS HC/MF A05 CSCL 09/3

An optically pumped molecular bromine laser was studied to investigate the quenching kinetics state of Br2. This included characterization of the pressure dependence of the laser output power. The approach was to excite molecular bromine in a sealed cell with a Nd:YAG pumped dye laser. Unresolved side fluorescence and amplified stimulated emission (ASE) spectra were recorded. ASE offered the advantage of a simpler optical system with no externally induced wavelength dependencies. Stimulated emission as a signal monitor offered greater resolution than side fluorescence spectra and facilitated spectroscopic assignment. GRA

**N91-20477#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**COMPUTER MODEL OF AN INJECTION LOCKED PULSED CO2 LASER M.S. Thesis**
Allen M. Susie Dec. 1990 69 p
(AD-A230680; AFIT/GE/ENP/90D-01) Avail: NTIS HC/MF A04 CSCL 09/3

With the discovery of the laser there have been continual attempts to increase the spectral brightness of a laser for

applications such as signal processing and lidar. To this end techniques using either passive or active cavity elements have been developed to isolate a single longitudinal mode in both continuous and pulsed laser systems. Although passive elements have useful applications in continuous systems their use in pulsed systems is difficult to control. The injection of an external signal has proved very successful. GRA

**N91-20478#** Department of the Navy, Washington, DC.
**IMPROVED GAS LASER AND PUMPING METHOD THEREFOR USING A FIELD EMITTER ARRAY Patent Application**
Henry F. Gray, inventor (to Navy) 12 Sep. 1990 26 p
(AD-D014762; US-Patent-Appl-SN-581620) Avail: NTIS HC/MF A03 CSCL 09/3

This patent application discloses an apparatus and method pumping a gas laser, wherein a field emitter is used to emit electrons into the gas to effect laser pumping. The low energy electrons emitted by field emitters, and the fine controllability of electron energy permitted by field emitters, enables one to effect population inversion of the laser gas, without ionizing the gas, or causing electrical breakdown. GRA

**N91-20479** Department of the Navy, Washington, DC.
**ROOM-TEMPERATURE, FLASHPUMPED, 2 MICRON SOLID STATE LASER WITH HIGH SLOPE EFFICIENCY Patent**
Leon Esterowitz, inventor (to Navy), Gregory J. Quarles, inventor (to Navy), and Charles L. Marquardt, inventor (to Navy) 6 Nov. 1990 8 p Filed 22 Dec. 1989 Supersedes AD-D014473
(AD-D014770; US-Patent-4,969,154; US-Patent-Appl-SN-455031; US-Patent-Class-372-68) Avail: US Patent and Trademark Office CSCL 09/3

A room temperature solid state laser for producing a laser emission at a wavelength of substantially 2 microns is disclosed. In a preferred embodiment, the laser comprises: a laser crystal having a host crystal material doped with an effective percent concentration of Cr(3+) sensitizer ions and with an effective percent concentration of Tm(3+) activator ions; and a flashpump for exciting the crystal to produce a laser emission at substantially 2 microns at a slope efficiency of at least 2 percent. GRA

**N91-20480#** Department of the Navy, Washington, DC.
**PULSED LASER BEAM DEVIATION APPARATUS Patent**
Charles E. Bell, inventor (to Navy) and Jay S. Hall, inventor (to Navy) 27 Nov. 1990 9 p Filed 24 Apr. 1981
(AD-D014781; US-Patent-4,973,838; US-Patent-Appl-SN-257433; US-Patent-Class-250-234) Avail: US Patent and Trademark Office CSCL 09/3

A pulsed laser beam aiming apparatus is configurated such that substantially 100 percent of the energy from a pulsed laser beam from a Q-switched pulsed laser device is accurately aimed at a distant target/obstacle in space. The pulsed laser beam is reflected off of a multifacet polygonal mirror spinning about its axis and perpendicularly affixed to a rotatable azimuthal table wherein the spinning mirror provides elevational orientation, and, in conjunction with the rotatable azimuthal table, azimuthal orientation. Control circuit and associated equipment cause the Q-switched pulsed laser device to be triggered on when a facet of the mirror is in the proper elevational and azimuthal orientation for the pulsed laser beam to hit the target/obstacle. Correct aiming of the pulsed laser beam at the target/obstacle is accomplished when the coordinates thereof are specific only as an elevational angle 5 above and/or below the horizon and an azimuthal angle between 0 and 360 degrees. GRA

**N91-20481#** Institut Franco-Allemand de Recherches, Saint-Louis (France).
**EXPERIMENTAL STUDIES OF HIGH AVERAGE POWER CO2-LASER-INDUCED THERMOMECHANICAL PROCESSES**
Manfred Hugenschmidt 20 Apr. 1990 16 p Presented at the International Congress on Optical Science and Engineering, The Hague, Netherlands, 12-16 Mar. 1990
(ISL-CO-202/90; ETN-91-98980) Avail: NTIS HC/MF A03

Pulsed high average power CO2 lasers allow for a most efficient conversion of coherence IR laser radiation into thermal and mechanical energies. Investigations using a specially developed repetitively pulsed high energy CO2 laser are presented. This powerful device provides mean powers of several kW and peak powers of the individual pulses in the multi-MW range. Studies were performed to obtain information on the transient behavior of the fast energy transfer mechanisms that occur at peak power densities near or above the surface plasma ignition thresholds. As shown, these plasma waves are periodically building up, expanding and recombining during the short time intervals between subsequent pulses, even in the case of the highest repetition rates that are presently limited to 100 Hz. Besides the efficient thermal energy transfer through plasma enhanced thermal coupling mechanisms, the simultaneously induced mechanical pressure waves are providing an additional impulsive loading of the targets. These pressures were investigated by using PVDF gauges. The experiments reveal that these effects are also responsible for improvements, concerning the energy balance, in most manufacturing processes such as in cutting or in drilling, where these fast thermomechanically coupled processes, for example, contribute to increase the mass removal rates. ESA

**N91-20482#** Royal Signals and Radar Establishment, Malvern (England).
**REFLECTIVITY ESTIMATES FOR LASER RANGEFINDER TARGETS AT 1.06 AND 2.06 MICRONS WAVELENGTHS**
M. J. P. Payne and H. W. Evans Oct. 1990 10 p
(RSRE-Memo-4339; BR115620; ETN-91-99000) Copyright Avail: NTIS HC/MF A02

Measurements of the reflectivities of some typical laser rangefinder target materials were made by two methods and at two wavelengths. The first method involved the measurement of the return signal strength in laser rangefinders operating on targets in the field with allowance for the geometry of the target. The second method employed a spectrometer in the laboratory to find the diffuse reflectivity of material samples. Some interpretation of the results is given, including especially the differences due to the wavelengths used. ESA

**N91-20483#** Maryland Univ., College Park. Lab. for Plasma Research.
**EXPERIMENTAL DEVELOPMENT OF A MILLIMETER WAVE FREE ELECTRON LASER**
D. J. Radack, S. W. Bidwell, T. M. Antonsen, Jr., Y. Carmel, W. W. Destler, V. L. Granatstein, P. E. Latham, B. Levush, I. D. Mayergoyz, and J. Rodgers et al 1990 4 p Presented at the 15th International Conference on Infrared and Millimeter Waves, Orlando, FL, 10-14 Dec. 1990
(Contract DE-FG05-87ER-52147)
(DE91-008318; CONF-901248-2) Avail: NTIS HC/MF A01

A 1 MW (CW), millimeter wave FEL (lambda sub 3 approximately 0.5 mm) is currently under development with an application for heating fusion plasmas. Two salient features of the FEL are the use of a short-period wiggler (I sub w less than or equal to 10 mm) electromagnet and a mildly relativistic (E sub beam less than or equal to 1 MeV) sheet electron beam. The FEL has been designed to operate in the high-gain regime and uses a tapered wiggler. The wiggler provides beam focusing as well as the magnetostatic pump wave. The effectiveness of wiggler focusing is being investigated. Planned experiments will address the critical issues of beam interception and stable single-mode operation. DOE

**N91-20484#** Maryland Univ., College Park. Lab. for Plasma Research.
**A HIGH-AVERAGE POWER TAPERED FEL AMPLIFIER AT SUBMILLIMETER FREQUENCIES USING SHEET ELECTRON BEAMS AND SHORT-PERIOD WIGGLERS**
S. W. Bidwell, D. J. Radack, T. M. Antonsen, Jr., J. H. Booske, Y. Carmel, W. W. Destler, V. L. Granatstein, B. Levush, P. E. Latham, and Z. X. Zhang 1990 15 p Presented at the 12th International Free Electron Laser Conference, Paris, France, 17-21 Sep. 1990

(Contract DE-FG05-87ER-52147)
(DE91-008319; CONF-9009166-19) Avail: NTIS HC/MF A03

A high-average-power FEL amplifier operating at submillimeter frequencies is under development at the University of Maryland. Program goals are to produce a CW, approximately 1 MW, FEL amplifier source at frequencies between 280 GHz and 560 GHz. To this end, a high-gain, high-efficiency, tapered FEL amplifier using a sheet electron beam and a short-period (superconducting) wiggler has been chosen. Development of this amplifier is progressing in three stages: (1) beam propagation through a long length (approximately 1 m) of short period (lambda(sub omega) = 1 cm) wiggler, (2) demonstration of a proof-of-principle amplifier experiment at 98 GHz, and (3) designs of a superconducting tapered FEL amplifier meeting the ultimate design goal specifications. DOE

**N91-20485#** Lawrence Livermore National Lab., CA.
**SURVEY OF ALTERNATIVE LASER SOURCES FOR BACKSCATTER ABSORPTION GAS IMAGING (BAGI)**
T. J. Kulp Jan. 1991 71 p
(Contract W-7405-eng-48)
(DE91-008444; UCRL-CR-104696) Avail: NTIS HC/MF A04

This report is the result of a Backscatter Absorption Gas Imaging (BAGI) development task in which the feasibility of imaging five gaseous species was to be evaluated. The five gases to be evaluated are carbon monoxide, carbon dioxide, hydrogen, hydrogen sulfide, and Halon. Because it is clear that some of these gases cannot be detected with the current BAGI system (based on the 9 to 11 micron carbon dioxide laser), it was decided that the feasibility of using BAGI at other wavelengths would be evaluated. This report summarizes the results of that study, and provides some comments on the feasibility of imaging the five gases. It is not intended to be a comprehensive compilation of all possible laser sources that can be used with BAGI, but rather a survey of some alternate configurations that might allow other gases/spectral regions to be covered. The scope of the survey will be limited to imaging systems of the same design as the present BAGI device; i.e., imagers that detect the absorption of backscattered laser radiation using x-y scanning optics in conjunction with a continuous-wave (CW) laser beam. It is conceivable that other types of laser-based gas-imaging devices may be feasible, as well. These might include sensors based on focal-plane detector arrays (using either CW or pulsed-laser sources) and sensors that use other spectral signals to visualize a plume. The evaluation of those possibilities for later work will be left for later. DOE

**N91-20486#** Los Alamos National Lab., NM.
**RECENT LASER EXPERIMENTS ON THE AURORA KrF/ICF LASER SYSTEM**
T. P. Turner, J. E. Jones, S. J. Czuchlewski, R. G. Watt, S. J. Thomas, M. Kang, C. R. Tallman, J. M. Mack, and J. F. Figueira 1990 13 p Presented at the International Conference on Lasers '90, San Diego, CA, 10-14 Dec. 1990
(Contract W-7405-eng-36)
(DE91-008607; LA-UR-91-728; CONF-901263-8) Avail: NTIS HC/MF A03

The Aurora KrF/ICF Laser Facility at Los Alamos is operational at the kilojoule-level for both laser and target experiments. We report on recent laser experiments on the system and resulting system improvements. DOE

# 37 MECHANICAL ENGINEERING

Includes auxiliary systems (nonpower); machine elements and processes; and mechanical equipment.

**N91-20487** Department of the Navy, Washington, DC.
**VIBRATION REDUCING THRUST BEARING Patent**
Thomas L. Daugherty, inventor (to Navy) 16 Oct. 1990 5 p Filed 13 Sep. 1989
(AD-D014720; US-Patent-4,963,039; US-Patent-Appl-SN-406410; US-Patent-Class-834-224) Avail: US Patent and Trademark Office CSCL 13/9

This patent discloses a thrust bearing for vibration reduction application which isolates the thrust shoes so that transmissions of vibrations induced by drag on the thrust shoes are attenuated or avoided. A thrust shoe carrier isolates the thrust shoes from the relatively stationary platform in which the bearing operates by providing a damped spring system with relatively low stiffness in the axial direction and relatively high stiffness in the torsional and radial directions. GRA

**N91-20488** Department of the Navy, Washington, DC.
**SYSTEM FOR LIMITING SNAP LOAD INTENSITY Patent**
James H. Dombrowski, inventor (to Navy), Herbert L. Mummery, inventor (to Navy), Roger W. Buecher, inventor (to Navy), and Isao R. Yumori, inventor (to Navy) 23 Oct. 1990 8 p Filed 11 Jul. 1989
(AD-D014730; US-Patent-4,964,491; US-Patent-Appl-SN-380950; US-Patent-Class-188-299) Avail: US Patent and Trademark Office CSCL 13/5

This patent discloses a system which limits the intensity of a snap load imposed in a tether or cable used; for example, in the recovery of an object at sea. It includes a floating plate for connection to the cable and a support housing for connection to the object being recovered. The system also includes an actuatable mechanism extending between and connected to the plate and housing. The actuatable mechanism is movable from an initial position toward a deflected position in response to the introduction of a snap load in the cable caused by the occurrence of the sudden removal of a slack condition in the cable. The system further includes a hydraulic or other fluid arrangement coupled to the actuatable mechanism for generating a shock load within the mechanism in response to the introduction of the snap load in the cable. This permits movement of the mechanism toward the deflected position while limiting the tensile load imposed on the cable to a known value that the cable can withstand. It also reduces the separation velocity toward zero. The system also includes a restoring mechanism operable for causing extension of the actuatable mechanism from the deflected position back to the initial position. This is in response to the re-introduction of another slack condition in the cable. GRA

**N91-20489*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**A MODEL FOR THE SPACE SHUTTLE MAIN ENGINE HIGH PRESSURE OXIDIZER TURBOPUMP SHAFT SEAL SYSTEM**
Daniel E. Paxson 1990 31 p Presented at the 2nd Annual Conference on Health Monitoring for Space Propulsion Systems, Cincinnati, OH, 14-15 Nov. 1990; sponsored by Cincinnati Univ.
(NASA-TM-103697; E-5919; NAS 1.15:103697) Avail: NTIS HC/MF A03 CSCL 13I

A simple static model is presented which solves for the flow properties of pressure, temperature, and mass flow in the Space Shuttle Main Engine pressure Oxidizer Turbopump Shaft Seal Systems. This system includes the primary and secondary turbine seals, the primary and secondary turbine drains, the helium purge seals and feed line, the primary oxygen drain, and the slinger/labyrinth oxygen seal pair. The model predicts the changes in flow variables that occur during and after failures of the various seals. Such information would be particularly useful in a post flight situation where processing of sensor information using this model could identify a particular seal that had experienced excessive wear. Most of the seals in the system are modeled using simple one dimensional equations which can be applied to almost any seal provided that the fluid is gaseous. A failure is modeled as an increase in the clearance between the shaft and the seal. Thus, the model does not attempt to predict how the failure process actually occurs (e.g., wear, seal crack initiation). The results presented were obtained using a FORTRAN implementation of the model running on a VAX computer. Solution for the seal system properties is obtained iteratively; however, a further simplified implementation (which does not include the slinger/labyrinth

combination) was also developed which provides fast and reasonable results for most engine operating conditions. Results from the model compare favorably with the limited redline data available. Author

**N91-20490#** National Academy of Sciences - National Research Council, Washington, DC. Office of Japan Affairs.
**APPROACHES TO ROBOTICS IN THE US AND JAPAN: REPORT OF A BILATERAL EXCHANGE**
1990 32 p
(PB91-130419) Avail: NTIS HC/MF A03 CSCL 13I

Major themes are examined from the Bilateral Exchange on Approaches to Robotics in the United States and Japan. A sense of the discussion around a major topic of the U.S.-Japan meeting (cooperation), where and when it makes sense, between the United States and Japan in robotics research and development (R&D). Past experience is related areas of cooperative effort and criteria for evaluation are suggested and existing and needed frameworks for supporting collaborative efforts are discussed. It will be the challenge of the governments and industrialists of the United States and Japan to frame additional questions and to initiate steps toward realizing the next generation of robots. GRA

**N91-20491#** Imperial Coll. of Science and Technology, London (England).
**INFRARED STUDY OF PISTON RING TEMPERATURES IN A FIRED ENGINE Final Report**
H. A. Spikes Nov. 1990 32 p
(Contract DAJA45-89-C-0008)
(AD-A230136; R/D-6102-AN-01) Avail: NTIS HC/MF A03 CSCL 21/7

Sapphire windows were inserted in the liner of a Petter AV1 diesel engine to enable temperatures of piston lands and rings to be monitored during firing. The overall temperatures that were measured are comparable to those reported in the literature obtained using embedded thermocouples. However, the very fast response time and surface specificity of the infrared method has also enabled transient temperature changes which take place just after ignition to be observed. GRA

**N91-20492#** Ballistic Research Labs., Aberdeen Proving Ground, MD.
**SOLUTION OF THE LONG ROD PENETRATION EQUATIONS Final Report, Jun. - Oct. 1990**
William P. Walters and Steven B. Segletes Dec. 1990 42 p
(AD-A230156; BRL-TR-3180) Avail: NTIS HC/MF A03 CSCL 12/1

An exact solution is presented for the long rod penetration equations first formulated by Alekseevski in 1966 and independently by Tate in 1967. This analytical solution allows a faster and easier solution of the penetration equations, since stability considerations associated with any numerically integrated solutions are avoided. Additionally, an analytical solution provides greater insight into the penetration mechanism than a comparable numerically integrated solution. Author (GRA)

**N91-20493#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**A ROBOTIC TACTILE SENSOR INCORPORATING SILICON PLANAR TECHNOLOGY: A PIEZOELECTRIC POLYVINYLIDENE FLUORIDE FILM, AND ON-CHIP SIGNAL PROCESSING M.S. Thesis**
Robert C. Fitch, Jr. Dec. 1990 163 p
(AD-A230362; AFIT/GE/ENG/90D-21) Avail: NTIS HC/MF A08 CSCL 09/1

This research effort pursued the design, fabrication, and test of a robotic tactile sensor. The VLSI integrated circuit (IC) portion of the sensor included a 7 x 7 array of metal electrodes which were individually connected to identical MOSFET amplifiers. A 25 micrometers thick patch (6 mm x 6 mm) of piezoelectric polyvinylidene fluoride (PVDF) film was attached to the array with a non-conductive adhesive, thereby creating an array of taxels. Charge, generated by the PVDF film, was detected by the amplifiers. The outputs of these amplifiers were connected to onchip signal circuitry designed to produce a single stream of serial data. A problem with the signal processing circuit circumvented the proper operation of the entire IC. Therefore, an external multiplexer was used to analyze the performance of a 3 x 3 array of taxels located in the center of the 7 x 7 array. The key factor affecting the performance of the sensor was establishing a uniform initial charge state condition across the 3 x 3 array. Schemes for manifesting this condition were examined as well as characterization of taxel load response. A fundamental image recognition process successfully recognized an applied shape by comparing the pre-load, load, and post-load multiplexed output of the array. GRA

**N91-20494#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**DEBRIS PRODUCTION IN HYPERVELOCITY IMPACT ASAT ENGAGEMENTS M.S. Thesis**
Stephen K. Remillard Dec. 1990 101 p
(AD-A230467; AFIT/GSO/ENS/90D-15) Avail: NTIS HC/MF A06 CSCL 15/3

This study reviews laboratory experiments on hypervelocity impacts and applies the results from those experiments to predict the mass of debris produced, the number of particles, and the size distribution of the debris particles produced in an anti-satellite (ASAT) engagement using kinetic energy weapons. The three possible types of hypervelocity collisions are discussed and parameters are provided that will help predict what type of collisions will occur between a given projectile and a target satellite. Once the collision type is determined, various equations are supplied which can be used to calculate debris mass, etc. Next, a notional attack between a miniature homing vehicle, similar to the one used in the successful F-15 launched ASAT, and two different satellites are examined to show the methodology for predicting the results of an ASAT engagement. Finally, suggestions are presented which can help a commander minimize the creation of debris, and thus minimize the long-term collision hazard for spacecraft resulting from ASAT engagements using kinetic energy weapons. GRA

**N91-20495#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**USE OF GRASP FORCE FOCUS POSITIONING TO ENHANCE THE TORQUE RESISTANCE CAPABILITY OF ROBOTIC GRASPS M.S. Thesis**
Stephen G. Edwards 13 Dec. 1990 102 p
(AD-A230518; AFIT/GA/ENY/90D-5) Avail: NTIS HC/MF A06 CSCL 23/2

Three-point-contact grasps are unique in that the homogeneous solution for the contact forces always produces a grasp force focus. Careful positioning of this focus point in the grasp plane can help avoid two things; slipping at the contact points, and violation of joint torque limits. The focus placement method is explored theoretically by examining two types of grasps on cylinders: (1) fingertip grasps using three independently operated fingers, and (2) single-finger power grasps with one contact point on each of three links. Constraint maps are generated for various fingertip grasps in order to show how proper placement of the grasp force focus results in no-slip grasps. A specific single-power grasp, using a specific manipulator, is examined in order to show that joint torque limits also effect focus placement. The results show that optimal focus location is grasp-specific, and that torque direction also plays a role in the torque resistance capability of the grasp. GRA

**N91-20496#** Naval Ocean Systems Center, San Diego, CA.
**A HEAD COUPLED SENSOR PLATFORM FOR TELEOPERATED GROUND VEHICLES**
John R. McDonnell, Manuel R. Solorzano, Stephen W. Martin, and Alan Y. Umeda Dec. 1990 10 p
(AD-A230649) Avail: NTIS HC/MF A02 CSCL 17/5

This paper describes a remote vision system applicable to the teleoperation of unmanned ground vehicles. The features of the

remote vision system are presented along with a description of its components: a sensor suite, a head slaved platform, and a head mounted display. An emphasis is placed on the remote platform dynamics. Performance goals are discussed and nominal head trajectories generated for use in a simulation study which was conducted to determine if these goals are achievable. Simulation and experimental results demonstrate that the electromechanical pan and tilt prototype approaches the desired performance goals. An analytical formulation of the pan and tilt dynamics is also given. GRA

**N91-20497#** Aeronautical Research Labs., Melbourne (Australia).
**ENSURING THE INTEGRITY AND VERACITY OF AN INTERACTIVE FAULT DIAGNOSIS AND ISOLATION SYSTEM FOR A GAS TURBINE ENGINE**
G. A. Wallace Aug. 1990 41 p
(AD-A230724; ARL-PROP-TM-471; DODA-AR-006-124) Avail: NTIS HC/MF A03 CSCL 21/5

The tasks involved in developing a fault diagnosis expert system for a gas turbine engine are examined. Particular attention is given to the options available to maximize the quality of the advice given by the expert system. All phases of system development from knowledge acquisition, through system support are covered. A general example of diagnosis by engineering analysis is given to demonstrate the concepts involved. Using acquired knowledge, a limited qualitative fault model of the TF30-P3 gas turbine engine afterburner has been developed, and application to some fault case examples is described. GRA

**N91-20498#** Sandia National Labs., Albuquerque, NM.
**MICROMACHINED SENSORS AND ACTUATORS**
B. K. Smith 1991 7 p Presented at the Environmentally Conscious Manufacturing/Technology Applications Workshop, Albuquerque, NM, 20 Feb. 1991
(Contract DE-AC04-76DP-00789)
(DE91-008257; SAND-91-0327C; CONF-910279-9) Avail: NTIS HC/MF A02

Micromachining is a rapidly growing field which allows for the fabrication of extremely small sensors and actuators using many of the techniques common to microelectronics. Two methods are commonly used: bulk micromachining, which involves the sculpting of single crystal silicon, and surface micromachining, which uses etched thin films that have been deposited on the substrate. Sensors are the primary commercial application, but microactuators are being actively researched at several laboratories and universities. Sandia National Laboratories is pursuing applications of both bulk and surface micromachining for silicon microsensors, microactuators, and high-performance, silicon packages for microelectronics. DOE

**N91-20499#** Lawrence Livermore National Lab., CA.
**WELDABILITY OF AERMET 100**
D. D. Kautz, D. E. Hoffman, and C. N. Westrich Jan. 1991 10 p
(Contract W-7405-eng-48)
(DE91-008626; UCRL-ID-106142) Avail: NTIS HC/MF A02

Several test welds were made on AerMet 100 alloy. Both electron beam and pulsed Nd:YAG laser beam welding processes were used to make the welds. All welds were satisfactory, with no cracking or porosity noted in weld cross-sections. DOE

**N91-20115*#** Army Aviation Systems Command, Cleveland, OH. Propulsion Directorate.
**ADVANCED ROTORCRAFT TRANSMISSION TECHNOLOGY**
David G. Lewicki *In* NASA, Lewis Research Center, Aeropropulsion 1991 Mar. 1991 15 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 13I

**N91-20642*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**RESOLVED RATE AND TORQUE CONTROL SCHEMES FOR LARGE SCALE SPACE BASED KINEMATICALLY REDUNDANT MANIPULATORS**
Robert W. Bailey (LinCom Corp., Houston, TX.) and Leslie J. Quiocho *In its* Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 2-8 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

**N91-20643*#** Teledyne Brown Engineering, Huntsville, AL.
**IVA THE ROBOT: DESIGN GUIDELINES AND LESSONS LEARNED FROM THE FIRST SPACE STATION LABORATORY MANIPULATION SYSTEM**
Carl R. Konkel, Allen K. Powers, and J. Russell Dewitt *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 9-14 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

**N91-20644*#** New Mexico Univ., Albuquerque. Dept. of Mechanical Engineering.
**A NOVEL DESIGN FOR A HYBRID SPACE MANIPULATOR**
Mo Shahinpoor *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 15-22 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

**N91-20645*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**FORWARD AND INVERSE KINEMATICS OF DOUBLE UNIVERSAL JOINT ROBOT WRISTS**
Robert L. Williams, II *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 23-29 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

**N91-20646*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**PERFORMANCE CAPABILITIES OF A JPL DUAL-ARM ADVANCED TELEOPERATION SYSTEM**
Z. F. Szakaly and A. K. Bejczy *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 30-41 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

**N91-20647*#** Martin Marietta Space Systems, Inc., Denver, CO.
**SSSFD MANIPULATOR ENGINEERING USING STATISTICAL EXPERIMENT DESIGN TECHNIQUES**
John Barnes *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 44-52 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

**N91-20648*#** Wisconsin Univ., Madison. Center for Space Automation and Robotics.
**IMPACT OF INERTIA, FRICTION, AND BACKLASH UPON FORCE CONTROL IN TELEMANIPULATION**
Neil A. Duffie, John J. Zik, Steven F. Wiker, and Karen L. Gale *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 53-58 (For primary document see N91-20641 12-59)
(Grant NAGw-975)
Avail: NTIS HC/MF A21 CSCL 13I

**N91-20649*#** Michigan Univ., Ann Arbor. Artificial Intelligence Lab.
**ADAPTIVE CONTROL OF SPACE BASED ROBOT MANIPULATORS**
Michael W. Walker and Liang-Boon Wee *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 59-66 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

**N91-20650*#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. Dept. of Electrical and Computer Engineering.
**THE AFIT GROSS MOTION CONTROL PROJECT**
M. B. Leahy, Jr. *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 67-73 Sponsored in part by AMRL, Wright-Patterson AFB, OH (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

**N91-20651*#** National Aeronautics and Space Administration, Washington, DC.
**NASA PLANETARY ROVER PROGRAM**
David Lavery and Roger J. Bedard, Jr. (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 78-83 Previously announced in IAA as A91-13756 (For primary document see N91-20641 12-59)
(Contract NAS7-918; NAGw-1175)
Avail: NTIS HC/MF A21 CSCL 13I

**N91-20652*#** California Cybernetics Corp., Sunland.
**AN ARCHITECTURAL APPROACH TO CREATE SELF ORGANIZING CONTROL SYSTEMS FOR PRACTICAL AUTONOMOUS ROBOTS**
Helen Greiner *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 84-90 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

**N91-20653*#** Carnegie-Mellon Univ., Pittsburgh, PA. Robotics Inst.
**A SIMPLE 5-DOF WALKING ROBOT FOR SPACE STATION APPLICATION**
H. Benjamin Brown, Jr., Mark B. Friedman, and Takeo Kanade *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 91-95 Sponsored in part by Shimizu Corp., Japan (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

**N91-20654*#** Carnegie-Mellon Univ., Pittsburgh, PA. School of Computer Science.
**PERCEPTION, PLANNING, AND CONTROL FOR WALKING ON RUGGED TERRAIN**
Reid Simmons and Eric Krotkov *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 96-102 (For primary document see N91-20641 12-59)
(Grant NAGw-1175)
Avail: NTIS HC/MF A21 CSCL 13I

**N91-20655*#** Wisconsin Univ., Madison. Center for Space Automation and Robotics.
**COMPARISON OF FORCE AND TACTILE FEEDBACK FOR GRASP FORCE CONTROL IN TELEMANIPULATION**
Steven F. Wiker, Neil A. Duffie, Thomas Y. Yen, and Karen L. Gale *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 104-112 (For primary document see N91-20641 12-59)
(Grant NAGw-975)
Avail: NTIS HC/MF A21 CSCL 13I

**N91-20656*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**AUTONOMOUS PROXIMITY OPERATIONS USING MACHINE VISION FOR TRAJECTORY CONTROL AND POSE ESTIMATION**
Timothy F. Cleghorn and Stanley R. Sternberg (Machine Vision International Ltd., Ann Arbor, MI.) *In its* Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 113-119 (For primary document see N91-20641 12-59)
(Contract NAS9-17814)
Avail: NTIS HC/MF A21 CSCL 13I

**N91-20658*#** Spectra Research Systems, Inc., Huntsville, AL.
**EVALUATION OF TELEROBOTIC SYSTEMS USING AN INSTRUMENTED TASK BOARD**
John D. Carroll, Paul A. Gierow, and Thomas C. Bryan *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 126-131 (For primary document see N91-20641 12-59)
(Contract NAS8-36307)
Avail: NTIS HC/MF A21 CSCL 13I

**N91-20659*#** Spar Aerospace Ltd., Weston (Ontario). Space Operations Div.
**OPERATIONS WITH THE SPECIAL PURPOSE DEXTROUS MANIPULATOR ON SPACE STATION FREEDOM**
B. Cox, D. Brown, and M. Hiltz *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 134-142 Sponsored in part by Canadian Space Agency, Houston, TX (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

**N91-20660*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**A SPACE SERVICING TELEROBOTICS TECHNOLOGY DEMONSTRATION**
Edwin P. Kan and Neville I. Marzwell *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 143-150 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

**N91-20662*#** New Mexico Univ., Albuquerque. Dept. of Mechanical Engineering.
**DEPLOYABLE ROBOTIC WOVEN WIRE STRUCTURES AND JOINTS FOR SPACE APPLICATIONS**
Mo Shahinpoor and Bradford Smith (Woven Wire Corp., Santa Fe, NM.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 159-166 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

**N91-20665*#** National Aeronautics and Space Administration, Washington, DC.
**GROUND CONTROLLED ROBOTIC ASSEMBLY OPERATIONS FOR SPACE STATION FREEDOM**
Joseph C. Parrish *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 184-191 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

# 38 QUALITY ASSURANCE AND RELIABILITY

Includes product sampling procedures and techniques; and quality control.

**N91-20500*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**THERMAL SHOCK TESTING FOR ASSURING RELIABILITY OF GLASS-SEALED MICROELECTRONIC PACKAGES**
Walter B. Thomas, III and Michael D. Lewis (Unisys Corp., Lanham, MD.) Washington Mar. 1991 41 p
(NASA-TM-104537; Rept-91B00078; NAS 1.15:104537) Avail: NTIS HC/MF A03 CSCL 14D

Tests were performed to determine if thermal shocking is destructive to glass-to-metal seal microelectronic packages and if thermal shock step stressing can compare package reliabilities. Thermal shocking was shown to be not destructive to highly reliable glass seals. Pin-pull tests used to compare the interfacial pin glass strengths showed no differences between thermal shocked and not-thermal shocked headers. A 'critical stress resistance temperature' was not exhibited by the 14 pin Dual In-line Package (DIP) headers evaluated. Headers manufactured in cryogenic nitrogen based and exothermically generated atmospheres showed differences in as-received leak rates, residual oxide depths and pin glass interfacial strengths; these were caused by the different manufacturing methods, in particular, by the chemically etched pins used by one manufacturer. Both header types passed thermal shock tests to temperature differentials of 646 C. The sensitivity of helium leak rate measurements was improved up to 70 percent by baking headers for two hours at 200 C after thermal shocking. Author

**N91-20501#** California Univ., Berkeley. Dept. of Industrial Engineering and Operations Research.
**STOCHASTIC MODELS IN RELIABILITY Final Report, 1 Aug. 1989 - 30 Jun. 1990**
Sheldon M. Ross 30 Jun. 1990 5 p
(Grant AF-AFOSR-0424-89; AF Proj. 2304)
(AD-A230227; AFOSR-90-1195TR) Avail: NTIS HC/MF A01 CSCL 12/4

There were two principal accomplishments during the grant period. The first gives a more effective reordering role for processing jobs (that may not complete) on a multiprocessor system. This is shown to improve on the previously known MF (move to front) and MB (move to back) ordering rules. The other accomplishment was a new variance reduction method in simulation, using random hazards in a Markov process. GRA

**N91-20502#** Department of the Navy, Washington, DC.
**PHASE CANCELLATION ENHANCEMENT OF ULTRASONIC EVALUATION OF METAL-TO-ELASTOMER BONDING Patent Application**
Paul M. Gammell, inventor (to Navy) 17 May 1990 20 p
(AD-D014761; US-Patent-Appl-SN-524414) Avail: NTIS HC/MF A03 CSCL 13/8

This patent application discloses an invention whereby acoustical radiation is generated and applied to the bonding interface between a radiation transmissive material and a radiation attenuating material to determine adhesion quality by extraction of data from a response signal produced by echoes reflected from both the interface and the radiation entry surface on the radiation transmissive material exposed to the generated acoustical radiation. Signal phase cancellation between the echoes from the entry surface and bonding interface produce a signal signature from which the quality of bonding is evaluated. By partial attenuation of the echo from the entry surface, the signature is maximized. GRA

**N91-20209*#** New York City Technical Coll., Brooklyn, NY.
**FLUORESCENT PENETRANT INSPECTION**
Sankar Sastri *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 7 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 14D

**N91-20211*#** New York City Technical Coll., Brooklyn, NY.
**RADIOGRAPHIC INSPECTION**
Sankar Sastri *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 11-12 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 14D

**N91-20684*#** Mitre Corp., Houston, TX.
**A FAILURE MANAGEMENT PROTOTYPE: DR/Rx**
David G. Hammen, Carolyn G. Baker, Christine M. Kelly, and Christopher A. Marsh *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 347-354 (For primary document see N91-20641 12-59)
(Contract NAS9-18057)
Avail: NTIS HC/MF A21 CSCL 14D

**N91-20691*#** Rockwell International Corp., Houston, TX.
**CAPTURING, USING, AND MANAGING QUALITY ASSURANCE KNOWLEDGE FOR SHUTTLE POST-MECO FLIGHT DESIGN**
H. L. Peters, L. R. Fussell, M. A. Goodwin, and Roger D. Schultz (Abacus Programming Corp., Van Nuys, CA.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 397-404 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 14D

# 39 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance.*

**N91-20503*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**BUCKLING AND VIBRATION ANALYSIS OF A SIMPLY SUPPORTED COLUMN WITH A PIECEWISE CONSTANT CROSS SECTION**
Mark S. Lake and Martin M. Mikulas, Jr. Washington Mar. 1991 13 p
(NASA-TP-3090; L-16854; NAS 1.60:3090) Avail: NTIS HC/MF A03 CSCL 20K

An analysis and sample results for the lateral buckling and vibration of a compressively loaded column is presented whose cross section is piecewise constant along its length. The column is symmetric about its mid-span and consists of three sections, the center section having a stiffer cross section than the two identical end sections. Buckling and vibration characteristics of the column are determined from numerical solution of the exact eigenvalue problems. Parametric structural efficiency analyses are performed using a nondimensionalized set of governing equations to determine the optimum ratio between the lengths of the center section and the outer sections based on both buckling load and vibration frequency requirements. In these analyses, two relationships exist. One is between cross-sectional mass and the cross section, and the other is a high-efficiency scheme. The effect of axial load on vibration frequency is also examined and compared with that of a uniform column. Author

**N91-20504#** Technische Hogeschool, Delft (Netherlands). Faculty of Aerospace Engineering.
**FATIGUE, STATIC TENSILE STRENGTH, AND STRESS CORROSION OF AIRCRAFT MATERIALS AND STRUCTURES. PART 1: TEXT**
J. Schijve Mar. 1990 230 p Revised

(PB91-114553; LR-630-Pt-1) Avail: NTIS HC/MF A11 CSCL 20K

Chapters on stress concentrations, the stress intensity at crack tips, and residual stresses are presented. Knowledge about these subjects is essential for the discussion in subsequent chapters on static tensile strength, stress corrosion, and fatigue. The chapter on failure in tension covers the material tensile strength, the blunt notch strength (strength of notched elements), fracture toughness, and the residual strength of the cracked parts. Aspects of stress corrosion are discussed. The main emphasis is on fatigue of materials and structures. The fatigue life is divided into two periods: the crack initiation period and the crack growth period. The significance of the two periods for practical problems is emphasized and used in the discussion of several effects on fatigue. Separate chapters are presented on fatigue under constant-amplitude loading, fatigue under variable-amplitude loading, fatigue of joints, fatigue loads on aircraft structures, and fatigue of aircraft structures. GRA

**N91-20505*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**STATUS OF DSMT RESEARCH PROGRAM**

Paul E. McGowan, Mehzad Javeed, and Harold H. Edighoffer (Analytical Services and Materials, Inc., Newport News, VA.) Jan. 1991 31 p Presented at the 4th NASA/DoD CSI Conference, Orlando, FL, 5-7 Nov. 1990

(NASA-TM-102764; NAS 1.15:102764) Avail: NTIS HC/MF A03 CSCL 20K

The status of the Dynamic Scale Model Technology (DSMT) research program is presented. DSMT is developing scale model technology for large space structures as part of the Control Structure Interaction (CSI) program at NASA Langley Research Center (LaRC). Under DSMT a hybrid-scale structural dynamics model of Space Station Freedom was developed. Space Station Freedom was selected as the focus structure for DSMT since the station represents the first opportunity to obtain flight data on a complex, three-dimensional space structure. Included is an overview of DSMT including the development of the space station scale model and the resulting hardware. Scaling technology was developed for this model to achieve a ground test article which existing test facilities can accommodate while employing realistically scaled hardware. The model was designed and fabricated by the Lockheed Missile and Space Co., and is assembled at LaRc for dynamic testing. Also, results from ground tests and analyses of the various model components are presented along with plans for future subassembly and matted model tests. Finally, utilization of the scale model for enhancing analysis verification of the full-scale space station is also considered. Author

**N91-20506*#** Computer Software Management and Information Center, Athens, GA.

**NINETEENTH NASTRAN (R) USERS' COLLOQUIUM**

Washington NASA Apr. 1991 194 p Colloquium held in Williamsburg, VA, 22-26 Apr. 1991 Sponsored by NASA, Washington

(NASA-CP-3111; NAS 1.55:3111) Avail: NTIS HC/MF A09 CSCL 20K

The proceedings of the the Nineteenth NASTRAN Users' Colloquium held April 22 to 26, 1991 are presented. Topics covered include the application of finite elements in engineering, comparisons with other approaches, unique applications, pre- and postprocessing or auxiliary programs, and new methods of analysis with NASTRAN. For individual titles, see N91-20507 through N91-20519.

**N91-20507*#** Unisys Corp., Huntsville, AL.

**IMPROVED NASTRAN PLOTTING**

Gordon C. Chan *In* Computer Software Management and Information Center, Nineteenth NASTRAN (R) Users' Colloquium Apr. 1991 p 1-9 (For primary document see N91-20506 12-39)

Avail: NTIS HC/MF A09 CSCL 20K

The new 1991 COSMIC/NASTRAN version, compatible with the older versions, tries to remove some old constraints and make it easier to extract information from the plot file. It also includes some useful improvements and new enhancements. New features available in the 1991 version are described. They include a new PLT1 tape with simplified ASCII plot commands and short records, combined hidden and shrunk plot, an x-y-z coordinate system on all structural plots, element offset plot, improved character size control, improved FIND and NOFIND logic, a new NASPLOT post-prosessor to perform screen plotting or generate PostScript files, and a BASIC/NASTPLOT program for PC. Author

**N91-20508*#** Unisys Corp., Huntsville, AL.

**ONLINE NASTRAN DOCUMENTATION**

Horace Q. Turner and David F. Harper *In* Computer Software Management and Information Center, Nineteenth NASTRAN (R) Users' Colloquium Apr. 1991 p 10-13 (For primary document see N91-20506 12-39)

Avail: NTIS HC/MF A09 CSCL 20K

The distribution of NASTRAN User Manual information has been difficult because of the delay in printing and difficulty in identification of all the users. This has caused many users not to have the current information for the release of NASTRAN that could be available to them. The User Manual updates have been supplied with the NASTRAN Releases, but distribution within organizations was not coordinated with access to releases. The Executive Control, Case Control, and Bulk Data sections are supplied in machine readable format with the 91 Release of NASTRAN. This information is supplied on the release tapes in ASCII format, and a FORTRAN program to access this information is supplied on the release tapes. This will allow each user to have immediate access to User Manual level documentation with the release. The sections on utilities, plotting, and substructures are expected to be prepared for the 92 Release. Author

**N91-20509*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**EXPERIENCES IN PORTING NASTRAN (R) TO NON-TRADITIONAL PLATFORMS**

Gregory L. Davis and Robert L. Norton *In* Computer Software Management and Information Center, Nineteenth NASTRAN (R) Users' Colloquium Apr. 1991 p 14-21 (For primary document see N91-20506 12-39)

Avail: NTIS HC/MF A09 CSCL 20K

The 1990 UNIX version of NASTRAN was ported to two new platforms that are not supported by COSMIC: the Sun SPARC workstation and the Apple Macintosh using the A/UX version of UNIX. The experiences of the authers in porting NASTRAN is summarized here. Suggestions for users who might attempt similar ports are given. Author

**N91-20510*#** Butler Analyses, Towson, MD.

**MODELING OF CONNECTIONS BETWEEN SUBSTRUCTURES**

Thomas G. Butler *In* Computer Software Management and Information Center, Nineteenth NASTRAN (R) Users' Colloquium Apr. 1991 p 22-43 (For primary document see N91-20506 12-39)

Avail: NTIS HC/MF A09 CSCL 20K

It is demonstrated here that complete checkout of a basic substructure can be done under the special circumstance of a sliding connection with offsets. Stiff bar connectors make this possible so long as the bar coordinates are aligned with the displacement coordinates at the sliding surface. Author

**N91-20511*#** Butler Analyses, Towson, MD.

**MODELING A BALL SCREW/BALL NUT IN SUBSTRUCTURING**

Thomas G. Butler *In* Computer Software Management and Information Center, Nineteenth NASTRAN (R) Users' Colloquium Apr. 1991 p 44-50 (For primary document see N91-20506 12-39)

Avail: NTIS HC/MF A09 CSCL 20K

In the particular NASTRAN application discussed here, a nut was attached to a stationary structure. The object of the analysis

was to determine the vibration characteristics of the whole structure for various configurations; i.e., the evaluation of the mode shapes and frequencies when parts were moved to different mating positions. Details of the analysis are given. Author

**N91-20512*#** McDonnell-Douglas Space Systems Co., Huntsville, AL.
**NASTRAN GPWG TABLES FOR COMBINED SUBSTRUCTURES**
Tom Allen *In* Computer Software Management and Information Center, Nineteenth NASTRAN (R) Users' Colloquium Apr. 1991 p 51-65 (For primary document see N91-20506 12-39)
Avail: NTIS HC/MF A09 CSCL 20K

A method for computing the mass and center of gravity for basic and combined substructures stored in the NASTRAN Substructure Operating File (SOF) is described. The three step method recovers SOF data blocks for the relevant substructure, processes these data blocks using a specially developed FORTRAN routine, and generates the NASTRAN gridpoint weight generator (GPWG) table for the substructure in a PHASE2 SOF execution using a Direct Matrix Abstraction Program (DMAP) sequence. Verification data for the process is also provided. Author

**N91-20513*#** Butler Analyses, Towson, MD.
**MODELING AN ELECTRIC MOTOR IN 1-D**
Thomas G. Butler *In* Computer Software Management and Information Center, Nineteenth NASTRAN (R) Users' Colloquium Apr. 1991 p 66-75 (For primary document see N91-20506 12-39)
Avail: NTIS HC/MF A09 CSCL 20K

Quite often the dynamicist will be faced with having an electric drive motor as a link in the elastic path of a structure such that the motor's characteristics must be taken into account to properly represent the dynamics of the primary structure. He does not want to model it so accurately that he could get detailed stress and displacements in the motor proper, but just sufficiently to represent its inertia loading and elastic behavior from its mounting bolts to its drive coupling. Described here is how the rotor and stator of such a motor can be adequately modeled as a colinear pair of beams. Author

**N91-20514*#** Los Alamos Scientific Lab., NM. Advanced Engineering Technology.
**COMPUTER ANIMATION OF NASTRAN DISPLACEMENTS ON IRIS 4D-SERIES WORKSTATIONS: CANDI/ANIMATE POSTPROCESSING OF NASHUA RESULTS**
Janine L. Fales *In* Computer Software Management and Information Center, Nineteenth NASTRAN (R) Users' Colloquium Apr. 1991 p 76-86 (For primary document see N91-20506 12-39)
Avail: NTIS HC/MF A09 CSCL 20K

The capabilities of the postprocessing program CANDI (Color Animation of Nastran DIsplacements) were expanded to accept results from axisymmetric analysis. An auxiliary program, ANIMATE, was developed to allow color display of CANDI output on the IRIS 4D-series workstations. The user can interactively manipulate the graphics display by three-dimensional rotations, translations, and scaling through the use of the keyboard and/or dials box. The user can also specify what portion of the model is displayed. These developments are limited to the display of complex displacements calculated with the NASHUA/NASTRAN procedure for structural acoustics analysis. Author

**N91-20515*#** Tennessee Eastman Corp., Kingsport. Engineering Div.
**DISTILLATION TRAY STRUCTURAL PARAMETER STUDY: PHASE 1**
J. Ronald Winter *In* Computer Software Management and Information Center, Nineteenth NASTRAN (R) Users' Colloquium Apr. 1991 p 87-118 (For primary document see N91-20506 12-39)
Avail: NTIS HC/MF A09 CSCL 20K

The purpose here is to identify the structural parameters (plate thickness, liquid level, beam size, number of beams, tray diameter, etc.) that affect the structural integrity of distillation trays in distillation columns. Once the sensitivity of the trays' dynamic response to these parameters has been established, the designer will be able to use this information to prepare more accurate specifications for the construction of new trays. Information is given on both static and dynamic analysis, modal response, and tray failure details. Author

**N91-20516*#** Dynamic Engineering, Inc., Newport News, VA.
**EXPERIENCES WITH THE USE OF AXISYMMETRIC ELEMENTS IN COSMIC NASTRAN FOR STATIC ANALYSIS**
Michael J. Cooper and William C. Walton *In* Computer Software Management and Information Center, Nineteenth NASTRAN (R) Users' Colloquium Apr. 1991 p 119-161 (For primary document see N91-20506 12-39)
Avail: NTIS HC/MF A09 CSCL 20K

Discussed here are some recent finite element modeling experiences using the axisymmetric elements CONEAX, TRAPAX, and TRIAAX, from the COSMIC NASTRAN element library. These experiences were gained in the practical application of these elements to the static analysis of helicopter rotor force measuring systems for two design projects for the NASA Ames Research Center. These design projects were the Rotor Test Apparatus and the Large Rotor Test Apparatus, which are dedicated to basic helicopter research. Here, a genetic axisymmetric model is generated for illustrative purposes. Modeling considerations are discussed, and the advantages and disadvantages of using axisymmetric elements are presented. Asymmetric mechanical and thermal loads are applied to the structure, and single and multi-point constraints are addressed. An example that couples the axisymmetric model to a non-axisymmtric model is demonstrated, complete with DMAP alters. Recommendations for improving the elements and making them easier to use are offered. Author

**N91-20517*#** David Taylor Research Center, Bethesda, MD. Computational Mechanics Div.
**FINITE ELEMENT SOLUTION OF TRANSIENT FLUID-STRUCTURE INTERACTION PROBLEMS**
Gordon C. Everstine, Raymond S. Cheng, and Stephen A. Hambric *In* Computer Software Management and Information Center, Nineteenth NASTRAN (R) Users' Colloquium Apr. 1991 p 162-173 (For primary document see N91-20506 12-39)
Avail: NTIS HC/MF A09 CSCL 20K

A finite element approach using NASTRAN is developed for solving time-dependent fluid-structure interaction problems, with emphasis on the transient scattering of acoustic waves from submerged elastic structures. Finite elements are used for modeling both structure and fluid domains to facilitate the graphical display of the wave motion through both media. For the liquid, the use of velocity potential as the fundamental unknown results in a symmetric matrix equation. The approach is illustrated for the problem of transient scattering from a submerged elastic spherical shell subjected to an incident tone burst. The use of an analogy between the equations of elasticity and the wave equation of acoustics, a necessary ingredient to the procedure, is summarized. Author

**N91-20518*#** David Taylor Research Center, Bethesda, MD. Underwater Explosions Research Div.
**THE USE OF THE PLANE WAVE FLUID-STRUCTURE INTERACTION LOADING APPROXIMATION IN NASTRAN**
R. L. Dawson *In* Computer Software Management and Information Center, Nineteenth NASTRAN (R) Users' Colloquium Apr. 1991 p 174-186 (For primary document see N91-20506 12-39)
Avail: NTIS HC/MF A09 CSCL 20K

The Plane Wave Approximation (PWA) is widely used in finite element analysis to implement the loading generated by an underwater shock wave. The method required to implement the PWA in NASTRAN is presented along with example problems. A theoretical background is provided and the limitations of the PWA are discussed. Author

**N91-20519*#** Wright Research Development Center, Wright-Patterson AFB, OH.
**SENSITIVITY ANALYSIS AND OPTIMIZATION ISSUES IN NASTRAN Abstract Only**
V. A. Tischler and V. B. Venkayya *In* Computer Software Management and Information Center, Nineteenth NASTRAN (R) Users' Colloquium Apr. 1991 p 187 (For primary document see N91-20506 12-39)
Avail: NTIS HC/MF A09 CSCL 20K

The purpose is to develop procedures to extract sensitivity analysis information from COSMIC/NASTRAN and to couple it with a mathematical optimization package. At present, the analysis will be limited to stress, displacement, and frequency constraints with structures modeled with membrane elements, rods, and bar elements. Two types of sensitivity analysis are discussed: an adjoint variable approach which is most effective when the number of active constraints is significantly less than the number of physical variables, and an approach based on a first order approximation of a Taylor series. The latter approach is more effective when the number of independent design variables is significantly less than the number of active constraints. Author

**N91-20520#** Princeton Univ., NJ. Dept. of Civil Engineering.
**DYNAMIC RATE DEPENDENT ELASTOPLASTIC DAMAGE MODELING OF CONCRETE SUBJECT TO BLAST LOADING: FORMULATION AND COMPUTATIONAL ASPECTS Final Report, 1 Sep. 1988 - 31 Aug. 1990**
J. W. Ju 31 Oct. 1990 262 p
(Grant AF-AFOSR-0324-88; AF Proj. 2302)
(AD-A229964; PU/CEOR/SM-90-9; AFOSR-90-1182TR) Avail: NTIS HC/MF A12 CSCL 20/11

Advanced elastic-damage and elastoplastic-damage models are presented within the frameworks of both continuum damage mechanics and micromechanical damage mechanics. Novel energy based coupled elastoplastic continuum damage theories and computational algorithms are proposed, including rate dependent isotropic and anisotropic damage models. Efficient constitutive algorithms and extensive experimental validations are also performed. In addition, novel finite deformation elastoplastic continuum damage models are developed to account for large strains and high rates. On the other hand, advanced and state-of-the-art 2-D and 3-D micromechanical anisotropic damage models are proposed to physically simulate micromechanical microcracking kinetics (cleavage 1 and cleavage 2 processes) and damaged overall compliances for concrete materials under tensile and compressive loadings. These results are innovative, fundamental, and very useful in advanced damaged modeling. GRA

**N91-20521#** Naval Civil Engineering Lab., Port Hueneme, CA.
**A CONSTITUTIVE RELATIONSHIP BETWEEN CRACK PROPAGATION AND SPECIFIC DAMPING CAPACITY IN STEEL Final Report, Oct. 1984 - Apr. 1988**
R. L. Jones Oct. 1990 180 p
(AD-A230049; NCEL-N-1817) Avail: NTIS HC/MF A09 CSCL 20/11

An expression stating crack propagation as a function of specific damping capacity was developed. Development was based on the premise that fatigue damage is due to plastic work. Plastic work is calculated from changes in damping between fatigue cycles where the damping changes are assumed to result from an increase in size of the plastic zone at the tip of the crack. A series of fatigue tests, using 4340 and 1018 steel specimens, were monitored for damping changes during fatigue crack growth. Each notched and uncracked beam specimen was mounted in a knife-edge fixture and fatigued by a four-point load. The fatigue had a stress ratio of zero. Between fatigue load cycles, a vibration generator would resonate the specimen mounted in the knife-edge fixture. Strain measurements from the specimen, and force measurements from the vibration generator, were used to calculate internal damping. Test results were compared to a dynamic mathematical model of the cracked specimen to verify the crack growth-specific damping relationship. Two types of damping were noted in the region of the fatigue crack. First, dislocation damping at the crack tip was observed in 1018 steel for large plastic zones. Second, damping proportional to the beam slope at the crack was observed in 4340 steel for small plastic zones and attributed to rubbing of the crack faces. Experimental results of both types of damping are duplicated by a computer program of the mathematical model. GRA

**N91-20522#** David Taylor Research Center, Bethesda, MD.
**RESPONSE OF REGULARLY RIBBED FLUID LOADED PANELS**
G. Maidanik and J. Dickey Nov. 1990 32 p
(AD-A230088; DTRC-90/036) Avail: NTIS HC/MF A03 CSCL 20/1

This paper presents computer estimations of the response of mechanically driven regularly ribbed fluid loaded panels. The estimates are presented in terms of the spectral distribution of the acceleration of the panel and the spectral distribution of the pressures in the fluid. The ribs are defined in terms of line and line moment impedances; these may be mass, resistance, and/or stiffness controlled, and of various values and combinations. Typical estimations of the spectral distribution of the magnitudes of the acceleration are displayed as functions of the normalized wavenumber that lies in the plane of the panel and normal to the ribs and the normalized frequency. The magnitudes of the acceleration vanish at the sonic loci when fluid loading is included. A sonic gorge, with a nadir at the sonic loci, characterizes the acceleration of the fluid loaded panel, whether unribbed or ribbed. If the magnitudes of the line impedances (and, when appropriate, also the line moment impedances) of the ribs are not unusually high, the magnitudes of the acceleration and their patterns elsewhere in the spectral domain remain substantially similar to those obtained in the absence of fluid loading. GRA

**N91-20523#** Naval Postgraduate School, Monterey, CA.
**CONSTRAINED VISCOELASTIC LAYER DAMPING OF THICK ALUMINUM PLATES: DESIGN ANALYSIS, AND TESTING M.S. Thesis**
Michael J. Bateman Mar. 1990 116 p
(AD-A230295) Avail: NTIS HC/MF A06 CSCL 20/11

Modern naval warfare has been increasingly dependent upon the acoustic silencing of the participants. Constrained viscoelastic layer damping of vibrating elements is one method which can be used to meet acoustic silencing goals. This paper considers constrained viscoelastic layer damping treatments applied to a thick aluminum plate, including single layer, double layer, a milled pocket plate, and a milled floating element configuration. High modal damping values were obtained for each configuration. The Modal Strain Energy method, using finite element analysis to estimate modal loss factors, was investigated for use as a tool in constrained viscoelastic layer damping design. A comparison of experimentally measured frequency response and modal loss factors with those predicted by the modal strain energy method is presented to confirm the possible use of the modal strain energy method as a design tool. GRA

**N91-20524#** Washington Univ., Seattle. Dept. of Mechanical Engineering.
**DYNAMIC FRACTURE ANALYSIS BY MOIRE INTERFEROMETRY**
K. Arakawa, R. H. Drinnon, M. Kosai, and A. S. Kobayashi Dec. 1990 15 p
(Contract N00014-89-J-1276)
(AD-A230383; UWA/DME/TR-90/68) Avail: NTIS HC/MF A03 CSCL 20/11

Dynamic Moire interferometry was used to measure separately the u- and v-displacement fields surrounding a rapidly propagating crack tip in Homalite-100 and 7075-T6 aluminum alloy plates. This transient crack tip displacement data was then used to compute the dynamic stress intensity factor and the remote stress component. J-integral values was also estimated using the static approximate procedure. This static analysis provided the correct J

when the contour integral was taken within 3 mm of the crack tip. GRA

**N91-20525#** Northwestern Univ., Evanston, IL. Dept. of Materials Science.
**LOAD SHARING OF THE PHASES IN 1080 STEEL DURING LOW CYCLE FATIGUE**
R. A. Winholtz and J. B. Cohen Nov. 1990 30 p
(Contract N00014-80-C-0116)
(AD-A229735; TR-28) Avail: NTIS HC/MF A03 CSCL 11/6

By means of x ray diffraction, the stress response of the individual phases in a 1080 steel were measured. Specimens with pearlitic, spheroidal, and tempered martensitic microstructures were subjected to low cycle fatigue and the stress strain hysteresis loops were separated into components for the carbide and matrix phases. These results show that as the material yields in both tension and compression the carbides take a higher fraction of the load and thus the stress range experienced by the carbide phase is much higher than matrix during low cycle fatigue. GRA

**N91-20526#** United Technologies Research Center, East Hartford, CT.
**EXTREME TEMPERATURE STRAIN MEASUREMENT SYSTEM Final Report, 13 Sep. 1985 - 31 Jul. 1990**
Charles Hulse and Richard Bailey Aug. 1990 97 p
(Contract F33615-85-C-3208)
(AD-A229802; UTRC/R90-917280-1; WRDC-TR-90-3054) Avail: NTIS HC/MF A05 CSCL 20/11

A survey and a selection of optimum techniques was made of methods for making strain measurements on aerospace structures -320 to 1600 F. Experimental evaluations were made of the two best systems selected, a rod type extensometer and a capacitance device. The rod type extensometer proved experimentally to be the better approach, especially for accurately measuring the strain behavior of an aerospace material under load throughout typical ascent and atmospheric reentry cycles. Some efforts were also devoted to the development of sputtered strain gages on transferable metal foils. These results indicated that strain measuring devices of this type could be developed if appropriate funds for research were available. GRA

**N91-20527#** Aerospace Corp., El Segundo, CA.
**MULTI-MODE RANDOM RESPONSE ANALYSIS PROCEDURE Final Report**
Peter Broussinos and Alvar M. Kabe Jan. 1990 70 p
(Contract F04701-88-C-0089)
(AD-A230457; TR-0090(5533)-1; SSD-TR-90-53) Avail: NTIS HC/MF A04 CSCL 22/4

A frequency domain procedure for solving large-scale, multi-mode, multi-force, random vibration problems is described. The study was motivated by the need to perform transonic buffet load analyses for the Delta II/Global Positioning System (GPS) vehicle, for which wind-tunnel tests had been performed to collect fluctuating pressure data. The procedure can be applied to random response problems which are described by a general set of parameters. These include random support-excitation (base-shake) problems typical of component test situations. The main features of the procedure and the corresponding computer program, when compared to traditional procedures, are that, by taking advantage of modern computational capabilities, information such as frequency-dependent power spectral densities and cross-power densities can be used. To establish confidence in the implementation of the procedure, results from test problems were compared to values obtained by directly integrating the equations of motion in the time domain. These test problems, one of which was the Delta II/GPS, also demonstrate the feasibility of performing a buffet loads analysis in the time domain. GRA

**N91-20528#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**INVESTIGATION OF STRAIN CHARACTERISTICS OF GRAPHITE POLYETHERETHER KETONE USING A NONLINEAR ANALYSIS AND EXPERIMENTAL METHODS M.S. Thesis**
Stephen C. Gould Dec. 1990 145 p
(AD-A230527; AFIT/GAE/ENY/90D-08) Avail: NTIS HC/MF A07 CSCL 07/3

A geometric nonlinear technique is incorporated in a current finite element program. This nonlinear program allows material nonlinearity for calculating the stresses, strains and failure of composites. The improved program uses an updated Lagrangian to calculate the stresses and strains. In addition, it updates the fiber orientation due to displacement in order to calculate the updated stiffness matrix. This method is valuable for large strain values. The analytical data were compared to experimental data obtained from Graphite PolyEtherEtherKetone laminates. To obtain data two geometries were used. Digitized photographs were used to measure the angle change for large strains. GRA

**N91-20529#** Army Armament Research, Development and Engineering Center, Watervliet, NY.
**REVIEW OF ASTM SYMPOSIUM ON SURFACE CRACK GROWTH: MODELS, EXPERIMENTS, AND STRUCTURES Final Report**
W. G. Reuter, J. H. Underwood, and J. C. Newman Nov. 1990 21 p
(AD-A230645; ARCCB-TR-90033) Avail: NTIS HC/MF A03 CSCL 20/11

An overview of the ASTM symposium on surface cracks: models, experiments, and structures, held on 25 April 1988 in Sparks, Nevada, is presented. The background and objective for the symposium are described and the technical papers presented and published in the proceedings are summarized. The papers are in two general categories: (1) results of analytical models and experiments of surface-cracked specimens and components subjected to monotonic loading; and (2) experiments and analyses of fatigue-crack growth of surface cracks. GRA

**N91-20530#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**DAMPING OF LAYERED BEAMS WITH MIXED BOUNDARY CONDITIONS M.S. Thesis**
Eugene T. Cottle Dec. 1990 86 p
(AD-A230665; AFIT/GAE/ENY/90D-5) Avail: NTIS HC/MF A05 CSCL 20/11

For many years, viscoelastic materials have been used in damping treatments to control vibration. In order to optimize a damping treatment for maximum damping, a design engineer must be able to predict frequencies of vibration of damped normal modes and loss factors as a function of the design parameters. Theoretical models of layered beams have been developed, but to date, exact solutions have assumed boundary conditions to be the same for all layers. In this thesis, equations of motion for a damped, layered beam are solved for the longitudinal displacement of both elastic layers, as well as the lateral displacement of the composite beam. Test cases were run on a computer to verify the validity of the equations, and to compare results with previously published approximate methods. Results show that the software compares well with theory for cases in which simple theoretical solutions are available. GRA

**N91-20531#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**A COMPARISON OF THE OPTIMIZATION AND ANALYSIS OF DOUBLY CURVED SHELLS USING MSC/NASTRAN AND ASTROS M.S. Thesis**
John R. Dewsnap Dec. 1990 88 p
(AD-A230682; AFIT/GA/ENY/90D-4) Avail: NTIS HC/MF A05 CSCL 12/1

This study identified techniques and software available for the optimization of doubly curved shells and applied them in the context

of a large nozzle shape. An optimality criteria scheme that can reduce solution time was evaluated and compared to the Method of Feasible Directions. MSC/NASTRAN and ASTROS were used to perform finite element analysis and optimization, and the results were compared to the theory. The programs give virtually identical results, and if plates and shells are carefully modeled, then stresses, displacements and modes are accurate to within ten percent. A Mindlin-type axisymmetric finite element was implemented in ASTROS that preserved accuracy and reduced the size of the stiffness matrix by a factor of four. Nozzle optimization was performed using static pressure and thermal loads, constrained by the Von Mises stress criteria. Software errors were documented in ASTROS, and four characteristic stress regions identified for the optimized nozzle. GRA

**N91-20532#** Southampton Univ. (England). Inst. of Sound and Vibration Research.
**ACQUIRING SEA PARAMETERS ON COMPLEX STRUCTURES BY A TRANSIENT TEST METHOD**
X. Wang and N. Lalor Jan. 1991 15 p
(ISVR-TR-192; ETN-91-98998) Avail: NTIS HC/MF A03

Statistical Energy Analysis (SEA) is recognized as a valid technique for solving structure noise and vibration problems. Equations showing that input power and vibration energy used in SEA can be expressed by only the point and cross mobility of the structure suggest that a hammer excitation transient technique can be used to determine the SEA parameters. A reported 8 dB disagreement on a complex structure is studied and a method for improving the steady state method for two coupled thin plates spot welded together is developed. This is achieved by introducing the coherence output spectrum into the vibration energy measurement. To overcome the limitations of hammer excitation, a combined steady state and transient technique is recommended. ESA

**N91-20533** National Physical Lab., Teddington (England). Div. of Materials Applications.
**BOLTED STRESS RELAXATION TESTING OF POLYMERIC MATERIALS**
M. P. Cook, D. Dawson, and K. Thomas Sep. 1990 18 p
(NPL-DMM(A)-12; ISSN-0959-2423; ETN-91-99021) Copyright Avail: National Physical Lab., Teddington, Middlesex, TW11 0LW, England

Under many service conditions, particularly where fasteners such as bolts are used to join dissimilar materials, compressive creep and stress relaxation are important. A topical example of this is bolting of plastics parts on to car engines. Previously behavior in this situation was determined by tightening the bolt with a torque spanner, and then measuring the torque to untighten after a chosen conditioning. This measurement can show large scatter, partly arising from frictional effects; and since only one result can be obtained at the end of each test, assessment of time dependence is tedious and inaccurate. Details of a new test designed to avoid these drawbacks, which was found to provide satisfactory continuous measurement of the fall in load in the bolted joint are reported. The test employs a 'load washer' to measure changes. It was shown elsewhere that the necessary disturbance of elastic conditions (which is minimized) does not significantly affect observed behavior. Test results obtained over a sufficient period may be empirically extrapolated to predict loads in service over several years. ESA

**N91-20534#** Los Alamos National Lab., NM.
**VIBRATION AND SHOCK RESPONSE OF THE BEAR (BEAM EXPERIMENT ABOARD A ROCKET) PAYLOAD DURING LAUNCH**
T. A. Butler Feb. 1991 23 p
(Contract W-7405-eng-36)
(DE91-007863; LA-11943-MS) Avail: NTIS HC/MF A03

Shock and vibration data obtained during the ARIES launch of the Beam Experiment Aboard a Rocket (BEAR) payload are presented, along with results from the preflight analysis and shock and vibration tests. Acceleration amplitudes were close to expected values. However, the frequency content of the loads experienced during separation shock was significantly different from that of the loads measured during the payload shock test. This result indicates the need for reevaluating the method of shock testing payloads that are launched with the ARIES booster. DOE

**N91-20535#** Lawrence Livermore National Lab., CA.
**A NEW ELASTOPLASTIC SHELL ELEMENT FORMULATION FOR DYNA3D**
B. E. Engelmann and R. G. Whirley Aug. 1990 37 p Presented at the DYNA3D Users Group Conference, Bournemouth, England, 18-19 Sep. 1990
(Contract W-7405-eng-48)
(DE91-008456; UCRL-JC-104826; CONF-9009348-1) Avail: NTIS HC/MF A03

The analysis of shell structures undergoing dynamic elastoplastic deformation is an important capability of DYNA3D. This paper presents an improved formulation for a 4-node quadrilateral shell element for explicit dynamic analysis. The proposed element is derived from a three-field weak form, and incorporates recently developed assumed strain methods for improved accuracy. In addition, the element is formulated in a large-displacement small-strain setting for minimum cost. Complex nonlinear constitutive models are easily incorporated into this formulation. Numerical examples illustrating the accuracy, robustness, and speed of the new element are shown. DOE

**N91-20536#** Michigan State Univ., East Lansing.
**SCALING THEORY AND SIMULATIONS OF FRACTURE IN DISORDERED MEDIA**
P. M. Duxbury and S. G. Kim 1990 12 p Presented at the American Society of Mechanical Engineers (ASME) Winter Annual Meeting, Dallas, TX, 25-30 Nov. 1990
(Contract DE-FG02-90ER-45418)
(DE91-008516; CONF-901194-13) Avail: NTIS HC/MF A03

Fracture in disordered media is a difficult problem due to a complex interplay between the intrinsic disorder and the evolution of damage. Extensions of network models used to study the elastic and transport properties of random media have been recently used to study fracture. Two representative examples of these models are discussed. Randomly diluted networks show a dilute limit singularity and size effect in tensile strength. Bounds on fracture critical exponents are found using percolation theory scaling arguments. Dilute limit fracture statistics obey a modified Gumbel form. Results on networks with random rigid and strong bonds are more preliminary. This system shows a crossover from brittle fracture to a damage mechanism as a function of the volume fraction of stiff inclusions. DOE

**N91-20537#** Lawrence Livermore National Lab., CA.
**TENSILE TESTING AT HIGH TEMPERATURES IN A GLOVEBOX**
M. P. Stratman 1 Oct. 1990 8 p
(Contract W-7405-eng-48)
(DE91-008994; UCRL-ID-104929) Avail: NTIS HC/MF A02

An apparatus has been designed and fabricated to perform high-temperature tensile tests in a glovebox environment. This apparatus was used to accomplish both high-temperature tensile tests and tests in a liquid metal environment. DOE

**N91-20538*#** State Univ. of New York, Buffalo. Computational Engineering Mechanics Lab.
**BEST3D USER'S MANUAL: BOUNDARY ELEMENT SOLUTION TECHNOLOGY, 3-DIMENSIONAL VERSION 3.0**
Mar. 1991 437 p Prepared in cooperation with Pratt and Whitney Aircraft, East Hartford, CT
(Contract NAS3-23697)
(NASA-CR-185298; NAS 1.26:185298) Avail: NTIS HC/MF A19 CSCL 20K

The theoretical basis and programming strategy utilized in the construction of the computer program BEST3D (boundary element solution technology - three dimensional) and detailed input instructions are provided for the use of the program. An extensive

set of test cases and sample problems is included in the manual and is also available for distribution with the program. The BEST3D program was developed under the 3-D Inelastic Analysis Methods for Hot Section Components contract (NAS3-23697). The overall objective of this program was the development of new computer programs allowing more accurate and efficient three-dimensional thermal and stress analysis of hot section components, i.e., combustor liners, turbine blades, and turbine vanes. The BEST3D program allows both linear and nonlinear analysis of static and quasi-static elastic problems and transient dynamic analysis for elastic problems. Calculation of elastic natural frequencies and mode shapes is also provided. Author

**N91-20104*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**OVERVIEW OF STRUCTURES RESEARCH**
Larry D. Pinson *In its* Aeropropulsion 1991 Mar. 1991 9 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 20K

**N91-20108*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**PROGRESS IN MODELING DEFORMATION AND DAMAGE**
Alan D. Freed and Steven M. Arnold *In its* Aeropropulsion 1991 Mar. 1991 9 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 20K

**N91-20210*#** New York City Technical Coll., Brooklyn, NY.
**MAGNETIC PARTICLE INSPECTION**
Sankar Sastri *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 9 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 20K

**N91-20217*#** Drexel Univ., Philadelphia, PA. Dept. of Materials Engineering.
**FRACTURE OF BRITTLE SOLIDS**
R. D. Doherty and S. K. Nash *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 41-45 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 07C

# 42 GEOSCIENCES (GENERAL)

**N91-20539*#** National Aeronautics and Space Administration, Washington, DC.
**SOLID EARTH SCIENCE IN THE 1990S. VOLUME 3: MEASUREMENT TECHNIQUES AND TECHNOLOGY**
Feb. 1991 177 p
(NASA-TM-4256-Vol-3; NAS 1.15:4256-Vol-3) Avail: NTIS HC/MF A09 CSCL 08G

Reports are contained from the NASA Workshop on Solid Earth Science in the 1990s. The techniques and technologies needed to address the program objectives are discussed. The Measurement Technique and Technology Panel identified (1) candidate measurement systems for each of the measurements required for the Solid Earth Science Program that would fall under the NASA purview; (2) the capabilities and limitations of each technique; and (3) the developments necessary for each technique to meet the science panel requirements. In nearly all cases, current technology or a development path with existing technology was identified as capable of meeting the requirements of the science panels. These technologies and development paths are discussed. Author

**N91-20540#** Army Cold Regions Research and Engineering Lab., Hanover, NH.
**IN-HOUSE LABORATORY INDEPENDENT RESEARCH PROGRAM, FY88 Special Report**
Deborah Diemand and Mary Moritz Oct. 1990 23 p
(AD-A229665; CRREL-SP-90-34) Avail: NTIS HC/MF A03 CSCL 08/12

The In-House Laboratory Independent Research (ILIR) Program provides a means for innovative high-risk basic research. This report briefly describes the 17 ILIR research projects undertaken in FY88. Work in this program addressed various problems concerning the physical properties of ice, snow and frozen ground; remote sensing of lake and river ice; water content of frozen or partially frozen materials; and physical/mathematical models for experimental or predictive use in ice research. GRA

**N91-20541*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**WEST ANTARCTIC ICE SHEET INITIATIVE. VOLUME 1: SCIENCE AND IMPLEMENTATION PLAN**
Robert A. Bindschadler, ed. Washington Apr. 1990 61 p Conference held in Greenbelt, MD, 16-18 Oct. 1990
(Grant NSF DPP-90-17562)
(NASA-CP-3115; Rept-91A01040-Vol-1; NAS 1.55:3115) Avail: NTIS HC/MF A04 CSCL 08B

The Science and Implementation Plan of the West Antarctic Ice Sheet Initiative (WAIS) is described. The goal of this initiative is the prediction of the future behavior of this ice sheet and an assessment of its potential to collapse, rapidly raising global sea level. The multidisciplinary nature of WAIS reflects the complexity of the polar ice sheet environment. The project builds upon past and current polar studies in many fields and meshes with future programs of both the U.S. and other countries. Important tasks in each discipline are described and a coordinated schedule by which the majority of these tasks can be accomplished in 5 years is presented. The companion report (Volume 2) contains seven discipline review papers on the state of knowledge of Antarctica and opinions on how that knowledge must be increased to attain the WAIS goal. Author

# 43 EARTH RESOURCES AND REMOTE SENSING

Includes remote sensing of earth resources by aircraft and spacecraft; photogrammetry; and aerial photography.

For instrumentation see *35 Instrumentation and Photography.*

**N91-20542#** National Geodetic Survey, Rockville, MD. Charting and Geodetic Services.
**THE APPLICATION OF MINIMUM-CURVATURE-DERIVED SURFACES IN THE TRANSFORMATION OF POSITIONAL DATA FROM THE NORTH AMERICAN DATUM OF 1927 TO THE NORTH AMERICAN DATUM OF 1983**
Warren T. Dewhurst Jan. 1990 36 p
(PB91-124131; NOAA-TM-NOS-NGS-50) Avail: NTIS HC/MF A03 CSCL 08B

A transformation technique that facilitates the conversion of quantities of coordinate data from the North American Datum of 1927 to the North American Datum of 1983 was designed. This approach relies upon modeling first- and second-order geodetic data, originally involved with the creation of NAD 83, and interpolating shift values as correctors to desired points. The modeling method employs the minimization of total curvature associated with surfaces defining the differences between datums. The accuracy of the datum transformation is a function of original data quality as well as proximity of existing control to new or desired points. In general, transformations can be expected at the 15 centimeter level for land mass of the conterminous United States and several meters far off-shore. These accuracies are believed to be sufficient for most of the Nation's land surveying

and mapping requirements. In all, NADCON results meet National Mapping Accuracy Standards and should be appropriate for a vast number of applications. Author

**N91-20543#** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**ACTIVE AND PASSIVE REMOTE SENSING OF ICE Annual Technical Report, 1 Oct. 1989 - 30 Sep. 1990**
Son V. Nghiem 26 Nov. 1990 18 p
(Contract N00014-89-J-1107)
(AD-A229648) Avail: NTIS HC/MF A03 CSCL 08/12

Fully polarimetric scattering of electromagnetic waves from snow and sea ice is studied with a layered random medium model and applied to interpret experimental data obtained under laboratory controlled conditions. The snow layer is modeled as an isotropic random medium. The sea ice is described as an anisotropic random medium due to the elongated form of brine inclusions. The underlying sea water is considered as a homogeneous half-space. The scattering effects of both random medium are described by three dimensional correlation functions with variances and correlation lengths corresponding to the fluctuation strengths and the physical geometry of the inhomogeneities, respectively. The strong fluctuation theory is used to calculate the effective permittivities of the random media. The distorted Born approximation is then applied to obtain the covariance matrix which describes the full polarimetric scattering properties of the remotely sensed media. GRA

**N91-20544#** Alabama Univ., University. School of Engineering.
**EXTENSION AND UPGRADING OF THE COMPUTER SIMULATION OF RANGE RELATIVE DOPPLER PROCESSING AND INVARIANT MAPPING FOR MM WAVE SEEKERS, VOLUME 1 Interim Technical Report, 3 Apr. - 31 Dec. 1988**
Robert J. Polge, Bassem R. Mahafza, and Jong G. Kim Oct. 1990 110 p
(Contract DAAH01-87-D-0021)
(AD-A229804; AD-E951580; AMSMI-CR-RD-AS-90-3-Vol-1)
Avail: NTIS HC/MF A06 CSCL 17/9

The computer simulation is extended and updated of Range Relative Doppler Processing (RRDP), and Invariant Mapping for MM wave seekers, which was introduced in prior reports. A major difference between standard Synthetic Aperature and RRDP is that the return signal is heterodyned with respect to a synthetic signal corresponding to a fictitious scatterer at the center of the range cell. It follows that the implementation of RRDP depends critically on an accurate simulation of the round trip delay. For this purpose the round trip delay is expressed as a four dimensional third order Taylor expansion. The footprint reflectivity versus azimuth and range is transferred to an absolute x-y map using the Invariant Mapping Technique proposed earlier, which was greatly improved. The theory, formulas, FORTRAN implementation, and performance of the simulation is studied. A separate User Manual is also available in Volume 2. GRA

**N91-20545#** Alabama Univ., University. School of Engineering.
**EXTENSION AND UPDATING OF THE COMPUTER SIMULATION OF RANGE RELATIVE DOPPLER PROCESSING AND INVARIANT MAPPING FOR MM WAVE SEEKERS. VOLUME 2: USER MANUAL OF THE RANGE RELATIVE DOPPLER PROCESSING SIMULATION FOR MM WAVE SEEKERS Interim Report, 3 Mar. - 31 Dec. 1988**
Robert J. Polge, Bassem R. Mahafza, and Jong G. Kim Oct. 1990 48 p
(Contract DAAH01-87-D-0021)
(AD-A229805; AD-E951581; AMSMI-CR-RD-AS-90-3-Vol-2)
Avail: NTIS HC/MF A03 CSCL 17/9

A computer simulation of Range Relative Doppler Processing (RRDP) and Invariant Mapping for MM Wave Seekers was developed in Volume 1 entitled Extension and Upgrading of the Computer Simulation of Range Relative Doppler Processing and Invariant Mapping for MM Wave Seekers (3). Two Programs were developed FRRDP and CRRDP. These programs use the same input files: CRRDPI.INF (system parameters) and CLUTINFI.INP (clutter map). Execution of FRRDP generates a file FRRDPG.GRD which stores the footprint reflectivity versus azimuth and range. Execution of CRRDP generates a file GRRDPG.GRD which stores the footprint reflectivity versus absolute xy-y coordinates. Volume 1 contains all the theory, formulas, and listings. A user manual is presented for the computer simulation documented in Volume 1. With this manual MICOM personnel should be able to: (1) install the FORTRAN Software on an IBM PC/compatible; (2) duplicate the results presented; and (3) run the simulation for different clutter maps and targets. Author (GRA)

**N91-20546#** Alabama Univ., University. School of Engineering.
**EXTENSION AND UPDATING OF THE COMPUTER SIMULATION OF RANGE RELATIVE DOPPLER PROCESSING AND INVARIANT MAPPING FOR MM WAVE SEEKERS. VOLUME 3: SIMULATION OF A DOPPLER BEAM SHARPENING RADAR FOR MM WAVE SEEKERS Interim Report, 3 Apr. - 31 Dec. 1988**
Robert J. Polge, Bassem R. Mahafza, and Jong G. Kim Oct. 1990 78 p
(Contract DAAH01-87-D-0021)
(AD-A229806; AD-E951582; AMSMI-CR-RD-AS-90-3-Vol-3)
Avail: NTIS HC/MF A05 CSCL 17/9

The application is extended of Range Relative Doppler Processing RRDP and of the Invariant Mapping Technique to beam Doppler sharpening radars, where the goal is to map a large area on the ground. In this application the antenna follows a horizontal path while scanning a wide azimuth interval. Two programs are developed: DOPFP.FOR and DOPXY.FOR. The first detects targets with the sequence of footprints. The second program uses invariant mapping to generate a file which contains reflectivity data versus absolute coordinates for a selectable x-y window. An example illustrates the detection of (4) forty randomly distributed scatters. The performance is quite good, except that the azimuth resolution is poor for footprints at very low azimuth angles. All the results are in complete agreement with the theory. GRA

**N91-20547#** Defense Mapping Agency Systems Center, Reston, VA.
**DIGITAL PRODUCTION OF LANDSAT IMAGE MAPS IN THE MAP PUBLISHING ENVIRONMENT**
Robert F. Seebald 9 Nov. 1990 15 p Presented at the ACSM/ASPRS Auto Carto Conference, Baltimore, MD, 25-29 Mar. 1991
(AD-A230558) Avail: NTIS HC/MF A03 CSCL 08/2

In support of counter narcotics activities the Defense Mapping Agency has begun production of a series of Landsat image maps. Produced at a scale of 1:100,000, these Landsat image maps are compiled from recent Landsat Thematic Mapper scenes. Bands 7, 4, and 2 are combined in a false color composite. Intensification of selected features provides improved topographic detail. The enhanced Landsat imagery is combined with a UTM grid and margin information and compiled and color separated in a digital environment. The Map Publishing Environment (MPE) output is film separates, printed via a large format laser filmwriter. In support of this new production system, a unique development/production environment was created to bring the Government cartographers into direct contact with the system developers in order to facilitate rapid modifications and changes to the application software as necessary. GRA

**N91-20548#** Naval Oceanographic and Atmospheric Research Lab., Bay Saint Louis, MS.
**GEOMETRIC RECTIFICATION OF HIGH RESOLUTION AIRBORNE MULTISPECTRAL DATA**
Stephen C. Lingsch, Maria T. Kalcic, and H. C. Mesick 1990 2 p
(AD-A230696; NOARL-AB-90-351-043) Avail: NTIS HC/MF A01 CSCL 08/2

NOARL is developing techniques to map water depths in clear, shallow waters from multispectral imagery. The airborne multispectral system consists of a suite of sensors including the NOARL multispectral scanner, hydrographic airborne laser sounder,

Litton 72 Inertial Navigation System, Rockwell Collins Global Positioning System, and a radar altimeter on board a Navy P-3 aircraft. Using an airborne multispectral scanner as an bathymetry sensor requires an accurate geometric registration of measured depth points to image pixels. The absolute depth is derived from a source external to the multispectral sensor (i.e., laser sounder or ship derived depths). In order to accurately model the correlation between the depth and multispectral reflectance these depths must be mapped precisely to the multispectral imagery. Following the mapping procedure, regression techniques are employed to compute a depth for each pixel. Once depths are computed for the entire image, accurate positioning is required for merging independent flightlines to produce accurate high resolution bathymetric charts. GRA

**N91-20549#** Naval Oceanographic and Atmospheric Research Lab., Bay Saint Louis, MS.
**ACTIVE/PASSIVE OPTICAL HYDROGRAPHY**
Stephen P. Haimbach, Maria T. Kalcic, Stephen C. Lingsch, and Michael C. Harris 1990 5 p
(AD-A230697; NOARL-AB-90-351-046) Avail: NTIS HC/MF A01 CSCL 17/5

The Airborne Bathymetric Survey (ABS) concept was adopted by the Defense Mapping Agency and the Navy in 1985. The ABS system combines two independent sensors, an active lidar and a passive multispectral scanner using GPS satellite data for positioning, into one integrated system. The objective of the developmental effort was to build a system that is capable of rapidly charting coastal bathymetry from an aircraft in a variety of environmental conditions and to provide the software and algorithms necessary to process the data. The laser sounder and the multispectral scanner collect data in swaths beneath the aircraft. At an altitude of 500 meters, the swath width are about 270 and 840 meters, respectively. Since both are optical sensors, their bottom detection capabilities were limited by the water clarity. In relatively clear coastal waters they were able to measure depths down to 3 optical depths. GRA

**N91-20550#** Naval Oceanographic and Atmospheric Research Lab., Bay Saint Louis, MS.
**MICROWAVE SIGNATURES AND PHYSICAL CHARACTERISTICS OF SNOW COVERED AND DESALINATED YOUNG SEA ICE**
T. C. Grenfell, A. W. Lohanick, and C. T. Swift 1990 9 p
(AD-A230736; NOARL-PR-89-050-332) Avail: NTIS HC/MF A02 CSCL 08/12

Young sea ice with a snow cover experiences rapid metamorphosis at the snow ice interface due to the high salinity at the ice surface and the insulating effects of the snow. As a result, a slush layer often appears even under cold conditions which gives rise to significant modifications in the microwave signatures. Time series of observations and accompanying analysis will be reported for selected cases. Bare young sea ice which underwent several melt-freeze cycles was also observed. In this case, the ice sheet became almost completely desalinated giving rise to a stable signature intermediate between those of open water and the original ice sheet. Observations and a brief theoretical study are presented. GRA

**N91-20551#** Naval Oceanographic and Atmospheric Research Lab., Bay Saint Louis, MS.
**GLINT REMOVAL FROM MULTISPECTRAL IMAGERY OVER CLEAR WATER**
Maria T. Kalcic and Stephen C. Lingsch 1990 2 p
(AD-A230792; NOARL-AB-90-351-042) Avail: NTIS HC/MF A01 CSCL 20/6

Multispectral imagery over clear water provides information about the seafloor, in shallow coastal waters up to 20 m, which can be used to model depth, bottom type and seafloor texture. Glint, or specular reflection off the sea surface, is often present, thus masking the effect of bottom reflectance on algorithms which model the seafloor. Glint can be effectively removed in cases where the water is very clear due to the high correlation of glinted surfaces over multiple bandwidths. This information, used in conjunction with differences in attenuation between the visible and infrared portions of the electromagnetic spectrum, were used by Lyzenga to derive a method for glint removal. The technique presented here expounds on that method by adding a texture technique to break out bright areas, such as white sandy shoals, that sometimes alias as glint, but have different texture, and by adding a quadratic term to the correction model. GRA

**N91-20164#** Joint Publications Research Service, Arlington, VA.
**SATELLITE GEODESY AND EARTHQUAKE PREDICTION**
M. T. Prilepin *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 47-51 Transl. into ENGLISH from Zemlya i Vselennaya (Moscow, USSR), no. 3, May - Jun. 1990 p 13-19 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

# 44 ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells; global sources of energy; geophysical conversion; and windpower.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *28 Propellants and Fuels.*

**N91-20552#** American Wind Energy Association, Arlington, VA.
**WIND ENERGY APPLICATIONS AND TRAINING SYMPOSIUM**
1990 120 p Symposium held in San Francisco, CA, 19-28 Sep. 1990 Prepared in cooperation with American Solar Energy Society, Boulder, CO
(Contracts DE-FG02-88CH-10376; DE-FG02-90CH-10455)
(DE91-006703; CONF-9009334-Summ; CONF-9009335-Summ; CONF-9009336-Summ) Avail: NTIS HC/MF A06

Sixteen representatives from 11 developing nations participated in the 1990 Wind Energy Applications and Training Symposium (WEATS) program. Consistent with previous symposia, the format included classroom-style training and field trip experiences to acquaint the participants with the history and progress of wind energy development in the U.S., technologically and economically. Brief presentations about wind energy development in all the countries represented were made by the participants. Several reports were prepared and presented along with slides for further explanation. The one-on-one symposium wrap-up session on the last day continues to be a good method of discovering what can be the next step in working with each country to develop their wind energy potential. Seventeen papers have been indexed separately for inclusion on the data base. DOE

**N91-20553*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**PHOTOVOLTAIC SYSTEM CRITERIA DOCUMENTS. VOLUME 2: QUALITY ASSURANCE CRITERIA FOR PHOTOVOLTAIC APPLICATIONS**
John C. Koenig, Joseph W. Billitti, and John M. Tallon 15 Oct. 1979 34 p Prepared for DOE, Washington, DC
(Contract NAS7-100)
(NASA-CR-183317; JPL-5250-3-Vol-2; NAS 1.26:183317) Avail: NTIS HC/MF A03 CSCL 10A

Quality assurance criteria are described for manufacturers and installers of solar photovoltaic tests and applications. Quality oriented activities are outlined to be pursued by the contractor/subcontractor to assure the physical and operational quality of equipment produced is included. In the broad sense, guidelines are provided for establishing a QA organization if none exists. Mainly, criteria is provided to be considered in any PV quality assurance plan selected as appropriate by the responsible Field Center. A framework is established for a systematic approach to ensure that photovoltaic tests and applications are constructed in a timely and cost effective manner. Author

**N91-20554*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**PHOTOVOLTAIC SYSTEM CRITERIA DOCUMENTS. VOLUME 4: REVIEW CRITERIA FOR PHOTOVOLTAIC APPLICATIONS**
John C. Koenig, Joseph W. Billitti, and John M. Tallon 15 Oct. 1979 12 p Prepared for DOE, Washington, DC
(Contract NAS7-100)
(NASA-CR-183319; JPL-5250-3-Vol-4; NAS 1.26:183319) Avail: NTIS HC/MF A03 CSCL 10A

Guidelines are provided for the organization, preparation and conduct of program reviews for photovoltaic applications. These criteria apply to all photovoltaic applications. They include, but are not limited to, the following: (1) Conceptual design review; (2) Preliminary design review; (3) Critical design review; and (4) Operational readiness review. Contract goal's and objectives are met through program monitoring for cost, schedule, and performance for both managerial and technical elements for all PV applications activities. Author

**N91-20555*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**PHOTOVOLTAIC SYSTEM CRITERIA DOCUMENTS. VOLUME 6: CRITERIA FOR AUDITING PHOTOVOLTAIC SYSTEM APPLICATIONS AND EXPERIMENTS. REVISION A**
John C. Koenig, Joseph W. Billitti, and John M. Tallon 19 Sep. 1980 36 p Prepared for DOE, Washington, DC
(Contract NAS7-100)
(NASA-CR-183321; JPL-5250-3-Vol-6-Rev-A; NAS 1.26:183321) Avail: NTIS HC/MF A03 CSCL 10A

The criteria is defined for auditing photovoltaic system applications and experiments. The purpose of the audit is twofold: to see if the application is meeting its stated objectives and to measure the application's progress in terms of the National Photovoltaic Program's goals of performance, cost, reliability, safety, and socio-environmental acceptance. The information obtained from an audit will be used to assess the status of an application and to provide the Department of Energy with recommendations on the future conduct of the application. Those aspects are covered of a site audit necessary to produce a systematic method for the gathering of qualitative and quantitative data to measure the success of an application. A sequence of audit events and guidelines for obtaining the required information is presented. Author

**N91-20556*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**PHOTOVOLTAIC SYSTEM CRITERIA DOCUMENTS. VOLUME 1: GUIDELINES FOR EVALUATING THE MANAGEMENT AND OPERATIONS PLANNING OF PHOTOVOLTAIC APPLICATIONS**
John C. Koenig, Joseph W. Billitti, and John M. Tallon 15 Oct. 1979 27 p Prepared for DOE, Washington, DC
(Contract NAS7-100)
(NASA-CR-183316; JPL-5250-3-Vol-1; NAS 1.26:183316) Avail: NTIS HC/MF A03 CSCL 10A

Guidelines are provided to the Field Centers for organization, scheduling, project and cost control, and performance in the areas of project management and operations planning for Photovoltaics Test and Applications. These guidelines may be used in organizing a T and A Project Team for system design/test, site construction and operation, and as the basis for evaluating T and A proposals. The attributes are described for project management and operations planning to be used by the Field Centers. Specifically, all project management and operational issues affecting costs, schedules and performance of photovoltaic systems are addressed. Photovoltaic tests and applications include residential, intermediate load center, central station, and stand-alone systems. The sub-categories of system maturity considered are: Initial System Evaluation Experiments (ISEE); System Readiness Experiments (SRE); and Commercial Readiness Demonstration Projects (CRDP). Author

**N91-20557*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**PHOTOVOLTAIC SYSTEM CRITERIA DOCUMENTS. VOLUME 3: ENVIRONMENTAL ISSUES AND EVALUATION CRITERIA FOR PHOTOVOLTAIC APPLICATIONS**
John C. Koenig, Joseph W. Billitti, and John M. Tallon 15 Oct. 1979 20 p Prepared for DOE, Washington, DC
(Contract NAS7-100)
(NASA-CR-183318; JPL-5250-3-Vol-3; NAS 1.26:183318) Avail: NTIS HC/MF A03 CSCL 10A

The environmental issues and evaluation criteria relating to the suitability of sites proposed for photovoltaic (PV) system deployment are identified. The important issues are defined, briefly discussed and then developed into evaluation criteria. System designers are provided with information on the environmental sensitivity of PV systems in realistic applications, background material which indicates the applicability of the siting issues identified, and evaluation criteria are defined to facilitate the selection of sites that maximize PV system operation. Author

**N91-20558*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**PHOTOVOLTAIC SYSTEM CRITERIA DOCUMENTS. VOLUME 5: SAFETY CRITERIA FOR PHOTOVOLTAIC APPLICATIONS**
John C. Koenig, Joseph W. Billitti, and John M. Tallon 15 Oct. 1979 63 p Prepared for DOE, Washington, DC
(Contract NAS7-100)
(NASA-CR-183320; JPL-5250-3-Vol-5; NAS 1.26:183320) Avail: NTIS HC/MF A04 CSCL 10A

Methodology is described for determining potential safety hazards involved in the construction and operation of photovoltaic power systems and provides guidelines for the implementation of safety considerations in the specification, design and operation of photovoltaic systems. Safety verification procedures for use in solar photovoltaic systems are established. Author

**N91-20559#** Mississippi Univ., University. Physical Acoustics Research Lab.
**THEORETICAL AND EXPERIMENTAL STUDY OF THERMOACOUSTIC ENGINES Annual Summary Report, 1 Sep. 1989 - 1 Sep. 1990**
Richard Raspet, Henry E. Bass, and W. P. Arnott 20 Dec. 1990 117 p
(AD-A230700; PARGUM-90-12) Avail: NTIS HC/MF A06 CSCL 10/2

This report describes theoretical and experimental research on thermoacoustic engines. The work includes three principal components: (1) theoretical and experimental work performed at the Naval Postgraduate School, (2) theoretical investigation of the thermoacoustic engine from acoustic analysis rather then energy analysis, (3) and design of a low frequency thermoacoustic driver utilizing square pore material for the stack. An acoustic based theory was conducted to predict the onset of oscillation in a thermoacoustic driver and for the Q of the resonance and performed measurements. The experimental results agree well with the theory. An acoustic theory for thermoacoustic engines utilizing various stack geometries was developed. This theory was based on earlier work on sound propagation in arbitrary pore shapes. A thermoacoustic driver was designed based on the square pore theory. GRA

**N91-20560#** Midwest Research Inst., Golden, CO. Solar Energy Research Inst.
**PHOTOVOLTAIC MODULE RELIABILITY WORKSHOP**
L. Mrig, ed. 1990 300 p Presented at the Photovoltaic Module Reliability Workshop, Lakewood, 25-26 Oct. 1990
(Contract DE-AC02-83CH-10093)
(DE91-002120; SERI/CP-213-4079; CONF-9010316) Avail: NTIS HC/MF A13

The paper and presentations compiled in this volume form the Proceedings of the fourth in a series of Workshops sponsored by Solar Energy Research Institute (SERI/DOE) under the general theme of photovoltaic module reliability during the period 1986 to

1990. The reliability photovoltaic (PV) modules/systems is exceedingly important along with the initial cost and efficiency of modules if the PV technology has to make a major impact in the power generation market, and for it to compete with the conventional electricity producing technologies. The reliability of photovoltaic modules has progressed significantly in the last few years as evidenced by warrantees available on commercial modules of as long as 12 years. However, there is still need for substantial research and testing required to improve module field reliability to levels of 30 years or more. Several small groups of researchers are involved in this research, development, and monitoring activity around the world. In the U.S., PV manufacturers, DOE laboratories, electric utilities and others are engaged in the photovoltaic reliability research and testing. This group of researchers and others interested in this field were brought together under SERI/DOE sponsorship to exchange the technical knowledge and field experience as related to current information in this important field. The papers presented here reflect this effort. DOE

**N91-20561#** Sandia National Labs., Albuquerque, NM.
**MODELS FOR MULTIMEGAWATT SPACE POWER SYSTEMS**
M. W. Edenburn Jun. 1990 104 p
(Contract DE-AC04-76DP-00789)
(DE91-008008; SAND-86-2742) Avail: NTIS HC/MF A06

This report describes models for multimegawatt, space power systems which Sandia's Advanced Power Systems Division has constructed to help evaluate space power systems for SDI's Space Power Office. Five system models and models for associated components are presented for both open (power system waste products are exhausted into space) and closed (no waste products) systems: open, burst mode, hydrogen cooled nuclear reactor - turboalternator system; open, hydrogen-oxygen combustion turboalternator system; closed, nuclear reactor powered Brayton cycle system; closed, liquid metal Rankine cycle system; and closed, in-core, reactor thermionic system. The models estimate performance and mass for the components in each of these systems. DOE

**N91-20562#** California Univ., Berkeley. Lawrence Berkeley Lab.
**HYDROGENATED AMORPHOUS SILICON RADIATION DETECTORS: MATERIAL PARAMETERS, RADIATION HARDNESS, CHARGE COLLECTION Ph.D. Thesis**
S. Qureshi Jan. 1991 138 p
(Contract DE-AC03-76SF-00098)
(DE91-009082; LBL-30292) Avail: NTIS HC/MF A07

For nearly two decades now hydrogenated amorphous silicon has generated considerable interest for its potential use in various device applications namely, solar cells, electrolithography, large-area electronics etc. The development of efficient and economic solar cells has been on the forefront of this research. This interest in hydrogenated amorphous silicon has been motivated by the fact that amorphous silicon can be deposited over a large area at relatively low cost compared to crystalline silicon. Hydrogenated amorphous silicon, frequently abbreviated as a-Si:H, used in solar-cell applications is a micron or less thick. The basic device structure is a p-i-n diode where the i layer is the active layer for radiation to interact. This is so because intrinsic a-Si:H has superior electrical properties in comparison to doped a-Si:H which serves the purpose of forming a potential barrier on either end of the i layer. The research presented in this dissertation was undertaken to study the properties of a-Si:H for radiation detection applications in physics and medicine. DOE

**N91-20732*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**ATOMIC OXYGEN INTERACTION WITH SOLAR ARRAY BLANKETS AT PROTECTIVE COATING DEFECT SITES**
Bruce A. Banks, Bruce M. Auer, Sharon K. Rutledge, and Carol M. Hill (Case Western Reserve Univ., Cleveland, OH.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 726-732 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 10A

# 45 ENVIRONMENT POLLUTION

Includes atmospheric, noise, thermal, and water pollution.

**N91-20563#** Environmental Protection Agency, Research Triangle Park, NC. Atmospheric Research and Exposure Assessment Lab.
**VERTICAL OZONE FLUXES AND RELATED DEPOSITION PARAMETERS OVER AGRICULTURAL AND FORESTED LANDSCAPES**
James M. Godowitch 1990 32 p Repr. from Boundary-Layer Meteorology, v. 50, 1990 p 375-404
(PB91-109926; EPA/600/J-90/154) Copyright Avail: NTIS HC/MF A03 CSCL 13B

The spatial variability and temporal behavior of the vertical flux of ozone was investigated from turbulence measurements collected on aircraft flight legs in the daytime period during two consecutive summer experimental field studies. The data were obtained during horizontal flight legs conducted over agricultural crops and forested land in southeastern Pennsylvania, central Ohio, and western Tennessee/Kentucky. Results from individual experimental cases and statistics derived from all cases in each region are presented. Ozone flux generally exhibited a significant height dependency; strongest negative (downward) fluxes in the lowest level flight legs were primarily attributed to the uptake of ozone by the surface and vegetative cover while values were near-zero in the middle of the convective boundary layer in the afternoon period. As ozone flux was proportional to concentration, slightly higher fluxes were found in low level downwind urban plume segments where ozone concentrations were 10 to 20 ppb higher than in the surrounding area. Derived deposition velocity showed no such bias as a function of position across the urban plume. Ozone flux differences were not apparent between the more heavily forested sections and the primarily agricultural cropland areas in these regions. GRA

**N91-20564#** Office of Technology Assessment, Washington, DC.
**CHANGING BY DEGREES: STEPS TO REDUCE GREENHOUSE GASES: SUMMARY**
1991 59 p
(OTA-O-483) Avail: NTIS HC/MF A04; also available SOD HC $16.00 as 052-003-01223-5

The following topics are discussed: (1) climate change and greenhouse gases; (2) U.S. sectoral analysis and projections of CO2 emissions; (3) options for reducing U.S. emissions; and (4) U.S. influence on the rest of the world. K.S.

**N91-20565#** Environmental Protection Agency, Research Triangle Park, NC. Atmospheric Research and Exposure Assessment Lab.
**SAMPLING AND ANALYSIS FOR POLYCHLORINATED DIBENZO-P-DIOXINS AND DIBENZOFURANS IN AMBIENT AIR**
R. L. Harless, R. G. Lewis, D. D. McDaniel, and A. E. Dupuy 13 Jun. 1990 7 p
(PB91-131698; EPA/600/D-90/172) Avail: NTIS HC/MF A02 CSCL 13B

A short term study for determination of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in ambient air in Green Bay, Wisconsin, was completed. General Metals Works PS-1 air samplers equipped with particle filters and polyurethane foam (PUF) sorbent were used to sample ambient air for 24 hour periods. Analytical procedures based on high resolution gas chromatography high resolution mass spectrometry (HRGC-HRMS) were used for the analysis. Total concentrations detected in ambient air for PCDDs ranged from

0.78 to 1.7 pg/cu m and those for PCDFs ranged from 0.67 to 2.6 pg/cu m. Minimum limits of detection were in the range of 0.01 to 0.08 pg/cu m. GRA

**N91-20566#** Gas Research Inst., Chicago, IL.
**GLOBAL CLIMATE CHANGE: A GAS INDUSTRY PROGRAM ON GLOBAL CLIMATE ISSUES, JULY 1990**
Jul. 1990 11 p
(PB91-136408; GRI-90/0305) Avail: NTIS HC/MF A03 CSCL 13B

GRI initiated a program aimed at gaining a scientifically valid understanding of the implications of increased gas use on the global climate. The objectives of the program are to quantify methane emissions, evaluate the methane effectiveness factor, investigate cost effective reduction measures, and develop an international data base. The need for the program, the role for natural gas, and methane releases by industry are discussed. GRA

**N91-20567#** Transportation Research Board, Washington, DC.
**GLOBAL WARMING: TRANSPORTATION AND ENERGY CONSIDERATIONS, 1990**
E. L. Hillsman, F. Southworth, N. A. Irwin, W. F. Johnson, and C. L. Saricks 1990 78 p
(PB91-118919; TRB/TRR-1267; ISBN-0-309-05017-0; LC-90-44171) Avail: NTIS HC/MF A05 CSCL 13B

Topics addressed include: factors that may influence responses of the U.S. transportation sector to policies for reducing greenhouse gas emissions; implications of long-term climatic changes for transportation in Canada; review of technological and policy options for mitigating greenhouse gas emissions from mobile sources; initial assessment of roadway-powered electric vehicles; and funding transportation energy conservation programs with oil overcharge settlements. GRA

**N91-20568#** NSI Technology Services Corp., Research Triangle Park, NC.
**EVALUATION OF PARTICLE BEAM LIQUID CHROMATOGRAPHY/MASS SPECTROMETRY FOR THE ANALYSIS OF POLAR SEMIVOLATILE ORGANIC COMPOUNDS IN AIR SAMPLES Project Report, 15 Mar. - Jun. 1990**
Robert S. Whiton Oct. 1990 50 p
(Contract EPA-68-02-444)
(PB91-127746; EPA/600/3-90/091) Avail: NTIS HC/MF A03 CSCL 13B

The initial evaluation of a particle beam liquid chromatograph/mass spectrometer for the analysis of polar semivolatile organic compounds in air samples is described. The study concentrated on the following: (1) examining and optimizing instrumental operating parameters; (2) evaluating the ability of the instrument to generate classical electron impact mass spectra of representative compounds; (3) investigating the performance with chemical ionization; and (4) evaluating the potential for quantitative analysis with selected compounds. Test compounds included hydroxy-polycyclic aromatic hydrocarbons (PAH), nitro-PAH, amino-PAH, and hydroxynitro-PAH. The results of these experiments are described, and several problems found in the current particle beam interface design are discussed. GRA

**N91-20569** Tel-Aviv Univ. (Israel). Dept. of Geophysics and Planetary Sciences.
**A NUMERICAL MODEL FOR THE CHARGING OF POLY-DISPERSED AEROSOL PARTICLES BY ATTACHMENT OF ATMOSPHERIC IONS M.S. Thesis**
Yoav Yair Mar. 1988 101 p In HEBREW; ENGLISH summary
(ITN-91-85100) Copyright Avail: Tel-Aviv Univ., Exact Sciences Library, Ramat Aviv 69978, Israel

The steady state charge distribution of a polydispersed aerosol was found to depend on the particle concentration and charge distribution. Features found to be common to the three distributions used included: a decrease of the negative/positive ion ratio in the initial stages of charging, and a higher positive ion concentration throughout; for all particle size categories, negatively charged particle concentrations exceeded those of positively charged particles at aerosol concentrations of 1,000 to 2,000 particles/mL; at aerosol concentrations of 8,000 to 10,000 particles/mL, the most numerous size categories of particles, usually in the Aitken size-range, tend to carry more negative charge; large particles, which are 2 to 3 orders of magnitude less abundant, carry more positive charge; at concentrations of 20,000 to 50,000 particles/mL, negative and positive net charge values become comparable; and the time to reach a steady state increases with particle concentration, ranging from 1,200 sec at low concentrations to over 2 hrs at concentrations of 30,000 to 50,000 particles/mL. The effect of initial positive space charge was to shift the negatively charged particle predominance towards smaller particles, with a complete reversal of the balance at initial space-charge density of about 200 e/mL. The model usually gives smaller values for atmospheric conductivity than measured values, probably because, for high aerosol concentrations, the system will not reach a steady state in the time available. The vertical profile obtained agreed well with balloon measurements only above 10 km, because the role of aerosols in determining ion concentrations is negligible. This work showed that the final charge distribution is affected by the coexistence of particles of various sizes, since a space charge separation occurs between large and small particles, which affects other processes, such as coagulation. Also, the calculations show that attainment of a steady state requires a relatively long time, so that all other processes which may invalidate the assumption of a uniform aerosol concentration have to be taken into account. ISA

**N91-20570#** Air Force Geophysics Lab., Hanscom AFB, MA.
**WADOCT: AN ATMOSPHERIC DISPERSION MODEL FOR COMPLEX TERRAIN Report, May 1989 - May 1990**
Bruce A. Kunkel and Yutaka Izumi 9 May 1990 51 p
(AD-A229920; GL-TR-90-0124; ERP-1062) Avail: NTIS HC/MF A04 CSCL 24/1

WADOCT (Wind and Diffusion Over Complex Terrain) is a complex terrain dispersion model capable of running on a microcomputer. It consists of two models: (1) AFWIND, a surface-layer windflow model, and (2) AFTOX, a Gaussian puff dispersion model. The terrain induced wind field and the dispersion pattern are computed separately and independently of each other. Through a transformation scheme the location and shape of the plume footprint is then adjusted to the computed wind field. An evaluation of the model is presented using data from the AMADEUS and the Mountain Iron dispersion experiments. The evaluation shows that the model tends to underpredict the adjustment to the wind direction and overpredict the length and width of the plume footprint. GRA

# 46 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism.

For space radiation see *93 Space Radiation.*

**N91-20571*#** National Academy of Sciences - National Research Council, Washington, DC.
**ASSESSING THE NATION'S EARTHQUAKES**
1990 78 p Sponsored in part by NASA, NSF, DOE, USGS, NRC, FEMA and DARPA
(NASA-CR-188024; NAS 1.26:188024; LC-90-61573; ISBN-0-309-04291-7) Avail: NTIS HC/MF A05 CSCL 08K

The basic purposes of this report are: (1) to make a convincing case for the intrinsic value of regional seismic networks; (2) to describe the seriousness of persistent problems in the current configuration and operation of these networks; (3) to outline recommendations for their modernization and future evolution, in particular, their short-term integration and long-term affiliation with the U.S. National Seismic Network. Important supplementary

information is included in two appendices: a survey of regional seismic networks and implementation strategies for revitalization of regional seismic networks. Author

**N91-20572*#** California Univ., Santa Cruz. Institute of Tectonics.
**VISCOELASTIC DEFORMATION NEAR ACTIVE PLATE BOUNDARIES Status Report, 1 Apr. 1991**
Steven N. Ward Apr. 1991 11 p
(Grant NAG5-750)
(NASA-CR-188043; NAS 1.26:188043) Avail: NTIS HC/MF A03 CSCL 08G

Very Long Baseline Interferometry (VLBI) now has the capacity to monitor geodetic positions with precisions of a few 1 mm over continental baselines. For tectonic applications, one of the major products of the VLBI program is the determination of the rate of change of station locations. Vector site velocities are now routinely produced. One of the novel techniques, VLBI Euler poles, is discussed. Y.S.

**N91-20573#** Moscow State Univ. (USSR). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki.
**STOCHASTIZATION OF CHARGED PARTICLE MOTION NEAR MAGNETOTAIL CURRENT LAYER**
I. I. Alekseev, Kh. V. Geviksman, A. P. Kropotkin, and M. I. Sitnov 1989 19 p In RUSSIAN
(DE91-615704; NIIYaF-MGU-89-4/81) Avail: NTIS HC/MF A03

Charged particle dynamics near the magnetotail current layer in the parabolic magnetic field model, B = B(sub 0)(Z/L)e(sub x) + B(sub n)e(sub z), are considered (L is the typical acceleration scale of the B(sub 0) field component, parallel to the layer) in the area of kappa = (B(sub n)/B(sub 0))(L/rho(sub 0))exp 1/2 much less than 1 (rho(sub 0) - larmor particle radius in the B(sub 0) field). In this area, it is shown that stochastization of motion can be at least of two types, corresponding to the local and global (in the layer plane) adiabaticity violation. The model proposed to describe the second type stochasticity agrees with results of numeric simulation and in particular describes in the right way the dependence of stochasticity area size on the kappa parameter as well as the presence of resonance necklace at the boundary of this area. Evaluation of the diffusion coefficient near the boundary of the stochasticity area is conducted. DOE

**N91-20574#** Geophysical Observatory, Helsinki (Finland). Academy of Science and Letters.
**HOMOGENEITY OF GEOMAGNETIC VARIATIONS AT THE SODANKYLA OBSERVATORY**
Kirsti Kauristie, Tomasz Ernst, Jerzy Jankowski, Ari Viljanen, Johannes Kultima, Risto Pirjola (Finnish Meteorological Inst., Helsinki.), and Eero Kataja, ed. 1990 25 p
(FACL-76; ISBN-951-41-0644-X; ISSN-0355-0826) Avail: NTIS HC/MF A03

Geomagnetic variations and the associated electric field were recorded at four temporary stations around the Sodankyla Geophysical Observatory for ten days in August 1988. The distance from each station to the observatory was about 30 km. The main purpose was to study the spatial homogeneity of magnetic variations observed at Sodankyla, i.e., to find out whether there are any local induction effects in the recordings of Sodankyla. Analysis of geomagnetic induction vectors indicates a large-scale induction anomaly but in the 30 km scale the variations are practically homogeneous for periods ranging from 100 to 2500 s. According to magnetotelluric calculations, the conductivity structure at the stations is three-dimensional. The inhomogeneity of the primary source field due to ionospheric currents can be significant in the vicinity of Sodankyla. It causes problems in induction vector and magnetotelluric calculations. Standard deviation between recordings at different stations are calculated using only carefully selected events having a homogenous source field. Theoretical estimates indicate that spatial variations of the primary field may exceed the standard deviations obtained. Author

**N91-20575#** Naval Oceanographic and Atmospheric Research Lab., Bay Saint Louis, MS.
**THE STRUCTURE AND DYNAMICS OF TROPICAL-MIDLATITUDE INTERACTIONS Final Report**
Ronald Gelaro Jul. 1990 234 p Prepared in cooperation with Pennsylvania State Univ., University Park
(AD-A229904; NOARL-7) Avail: NTIS HC/MF A11 CSCL 04/2

The Navy is interested in many aspects of atmospheric and oceanic variability that can no longer be treated as mutually exclusive phenomena. For example, it has become clear that seasonal predictions of oceanic storm activity and cloudiness, as well as seasonal variations in most oceanic circulations, are evolving phenomena that are continually modified by feedbacks between the atmosphere and the ocean. At shorter time scales, the prospect for developing coupled whole earth prediction systems to provide better real time fleet support depends critically on the ability to identify and understand the processes that link the atmosphere and oceans. An understanding of the interactions between the tropical oceans and the atmosphere, developed within the context of the Navy's environmental prediction systems, is therefore essential for achieving naval environmental research goals regarding coupled air-sea model development and increased understanding of the role of oceanic processes in the global environment. The objective of the study described in this report is to investigate the influence of tropical ocean thermal anomalies on the general circulation of the atmosphere placing particular emphasis on the impact of these anomalies on the near term variability of the midlatitude flow. GRA

**N91-20576#** Royal Norwegian Council for Scientific and Industrial Research, Kjeller.
**APPLICATION OF REGIONAL ARRAYS IN SEISMIC VERIFICATION RESEARCH Report, 1 May - 31 Jul. 1990**
S. Mykkeltveit, F. Ringdal, T. Kvaerna, and R. W. Alewine 31 Aug. 1990 62 p
(Contract F49620-89-C-0038; ARPA Order 5307)
(AD-A229926; NORSAR-CONTRIB-418; GL-TR-90-0260; SR-6)
Avail: NTIS HC/MF A04 CSCL 08/11

The paper gives an account of the work related to the development of the NORESS concept of a regional array. The array design considerations and objectives are reviewed, and a description is given of the NORESS and ARCESS array facilities in Norway with their field installations, data transmission lines and data receiving center functions. The automatic signal detection processing of NORESS data applies multiple narrow-band frequency filters in parallel and forms array beams from selected subgeometries. The detection algorithm is based on computing the STA/LTA ratio for each beam individually, and a detection is declared whenever this ratio exceeds and given threshold. It is explained how the beam deployment and the individual threshold values can be tuned to ensure that the interesting phase arrivals are not missed, but at the same time avoiding coda detections. GRA

**N91-20577#** Weston Observatory, MA.
**NY-NEX RAYLEIGH WAVE SIGNAL AND NOISE ANALYSIS AT A SEISMIC ARRAY Report, Aug. - Dec. 1989**
Christopher J. Center 12 Mar. 1990 112 p
(Contract F19628-86-C-0055)
(AD-A230137; GL-TR-90-0068; SR-4) Avail: NTIS HC/MF A06 CSCL 08/11

Conventional frequency wave number processing of array data was used to estimate the azimuths and phase velocities of fundamental mode Rayleigh waves in the geology and ambient noise setting at North Haverhill, New Hampshire. These estimates are compared to true azimuths between known shot to array site locations to determine the horizontal refraction of Rg waves due to the regional geology and the variation of azimuth and phase velocity estimates due to additive noise. The analysis was based on calculations of the spectral density function P(Kx,Ky,f), a measure of power as a function of frequency and wave number for propagating waves. This study measured 0.3 to 1.0 second

period Rg waves with phase velocities ranging from 2.5 to 2.9 km/sec having refraction raypaths with a lateral velocity gradient. GRA

**N91-20578#** Naval Research Lab., Washington, DC.
**OPTICAL TURBULENCE MEASUREMENTS DURING ONE MORNING AND TWO EVENING TRANSITION PERIODS IN A DESERT BASIN Final Report, 1979 - 1989**
S. K. Searles, G. A. Hart, and K. E. Kunkel 31 Dec. 1990 13 p
(AD-A230304; NRL-9295) Avail: NTIS HC/MF A03 CSCL 04/1

Refractive index structure parameter data (c) recorded at 4, 8, 16, and 32 m heights over a desert basin three test periods of about two hours each near sunrise or sunset were analyzed. C between 4 and 8 m was found to be relatively constant. C at 8, 16, and 32 m were least-squares fit to c=c sub 0 (z/z sub 0) to the MTH power over 5 and 15 minute averaging periods. GRA

**N91-20579#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**THE USE OF THE LOWTRAN7 ATMOSPHERIC TRANSMITTANCE AND RADIANCE COMPUTER PROGRAM FOR DETECTION SYSTEM DESIGN AND ANALYSIS M.S. Thesis**
Kelli J. Owen Oct. 1990 112 p
(AD-A230426; AFIT/GEP/ENP/90D-3) Avail: NTIS HC/MF A06 CSCL 04/1

The purpose of this study is to demonstrate how the LOWTRAN7 computer model can be used for detection system design and analysis. The LOWTRAN7 code is an atmospheric model that performs low resolution (20/cm bandwidth) calculations to estimate atmospheric transmittance and radiance under a given set of conditions. Generic imaging and non-imaging systems are analyzed. A hypothetical figure-of-merit is evaluated for each type of system using the transmittance and radiance calculated by LOWTRAN7. The figure-of-merit calculated for the imaging system is contrast, the difference between the target and background input signals divided by the target input signal. The figure-of-merit evaluated for the non-imaging system is the change in signal (CS), the difference between the input signal with the target in the field-of-view and the input signal without the target in the field-of-view divided by the input signal without the target in the field-of-view. Changing atmospheric, target, and background characteristics in LOWTRAN7 has different effects on the figures-of-merit. The characteristics tested are: background emissivity, target temperature, boundary layer aerosols, atmospheric profiles, relative humidity, and absolute humidity. Two different sensor-target geometries using different paths are studied. GRA

**N91-20580#** Institute for Defense Analyses, Alexandria, VA.
**PHYSICS OF HIGH-TEMPERATURE AIR. PART 2: APPLICATIONS Final Report, Jan. 1989 - Jan. 1990**
Ernest Bauer Aug. 1990 178 p
(AD-A229778; AD-E501307; IDA-D-626-Pt-2; IDA/HQ-89-34632) Avail: NTIS HC/MF A09 CSCL 04/1

The specialized literature survey was made of several applied topics in the physics of high temperature air. Missile reentry (Chapter 5), nuclear weapons effects (Chapter 6), is discussed along with some topics in the propagation of electromagnetic radiation through the atmosphere (Chapter 7). A simple overview is presented of some key physical factors, and references are given of relevant textbooks and gray literature of technical reports specific to the field. Part 1 of these notes (IDA Document D-487, May 1990) consists of a general introduction (Chapter 1), a discussion of equilibrium air at temperatures to 10,000 K (Chapter 2), a discussion of the radiation from high-temperature air (Chapter 3), and (Chapter 4), which gives a brief discussion of some specific mechanisms for heating the earth's atmosphere, ranging from shock heating through nuclear explosions to solar ultraviolet radiation. GRA

**N91-20581#** Boston Univ., MA. Center for Space Physics.
**WAVE PARTICLE INTERACTIONS IN THE INNER MAGNETOSPHERE Final Report, 27 Feb. 1987 - 30 Jun. 1990**
W. J. Hughes Aug. 1990 22 p
(Contract F19628-87-K-0015)
(AD-A230493; GL-TR-90-0195) Avail: NTIS HC/MF A03 CSCL 04/1

This contract funded a three year study of wave particle interactions and substorm dynamics in the inner magnetosphere. The first ground/satellite study of ion cyclotron waves generated near the plasmapause was completed. Several examples of waves observed simultaneously near the equator at L=4 by the DE 1 spacecraft on the ground were published. In three cases correlation analysis yielded estimates of wave group delay between the equatorial source region and the ground. Model calculations that used measured plasma parameters agreed with observational estimates. Among substorm related work, an earlier study of pi2 signatures was extended to lower latitudes to show that substorm onset signatures broaden in longitudinal extent with decreasing latitude. It was shown that a pi2-based substorm detector would be a more reliable tool than one based on the AL index, and a simple pi2 index was developed and tested. The results showed that a more sophisticated pi2 index would result in fewer false detections. A new hypothesis on the triggering of substorms was formulated and testing begun. GRA

**N91-20582#** Air Force Geophysics Lab., Hanscom AFB, MA.
**PROCEEDINGS OF THE 8TH ANNUAL DARPA/AFGL SEISMIC RESEARCH SYMPOSIUM Environmental Research Papers**
James F. Lewkowicz and Jeanne M. McPhetres 3 Dec. 1990 230 p Symposium held in Colorado Springs, CO, 6-8 May 1986
(AD-A230519; GL-TR-90-0333; GL-ERP-1074) Avail: NTIS HC/MF A11 CSCL 17/10

The following subject areas are covered: resolution of source functions and structure from near-field data; seismic wave propagation in a laterally heterogeneous crust; modeling Lg propagation across crust-mantle transition zones and evaluating surface wave path corrections; geophysical investigations at Pahute Mesa, NV; regional studies with broadband data; determination of source function for a seismic swarm; damage mechanics of brittle solids in compression; sources spectra determination for a recent seismic crisis in the east part of France; focussing and defocussing of body waves by three-dimensional structure in source and receiver regions; regional event detection using the NORESS array; nature of teleseismic P coda at NORESS; propagation characteristics of regional phases and NORESS real time processing performance; wavefield decomposition using ML-probabilities in modelling single-site 3-component records - practical applications on locations of events and scattering; observational and theoretical studies of regional wave propagation; source characterization and yield estimation from Lg and P-Coda measurements; tectonic release signature at regional distances; Lg magnitudes of selected Shagan River, East Kazakhstan explosions; analysis of teleseismic P wave amplitude and coda variations for underground explosions; comparison of matched filters to time-variable filters for amplitude determination of normal modes in surface wave analysis. GRA

**N91-20583#** Boston Univ., MA. Center for Space Physics.
**MODELLING AND OBSERVATIONS OF THE EQUATORIAL IONOSPHERE Report, 1 Oct. 1987 - 30 Sep. 1988**
Michael Mendillo 10 Oct. 1990 20 p
(Contract F19628-86-K-0026)
(AD-A230631; AFGL-TR-89-0027; SR-1) Avail: NTIS HC/MF A03 CSCL 04/1

The equatorial ionosphere experiences one of the most severe forms of a geophysical plasma instability - a phenomenon known as spread F. An observational campaign was organized to bring a complement of diagnostic instruments to two sites in the western Pacific sector (Kwajalein Atoll in the Marshall Islands and Wake Island) for a period of coordinated optical and radio measurements of spread F phenomena in August 1988. All-sky optical imaging observations were conducted from 2 to 16 August in conjunction

with ALTAIR radar observations on Kwajalein. Preliminary review of the data sets obtained identified at least five case study events for detailed investigation. GRA

**N91-20584#** Lowell Univ., MA. Center for Atmospheric Research.
**DIGISONDE AT SONDRESTROM TO MONITOR THE IONOSPHERIC POLAR CAP AND CUSP REGION**
Geoffrey Crowley, Bodo W. Reinisch, and David F. Kitrosser Jan. 1990 42 p
(Contract F19628-87-C-0003)
(AD-A230705; ULRF-463/CAR; GL-TR-90-0088; SR-21) Avail: NTIS HC/MF A03 CSCL 04/1

In July 1989, the Air Force meridional chain of Digisondes was completed by the installation of a system in Sondrestromfjord, Greenland (66.98 deg N, 50.94 deg W). In this report, we describe the Sondrestrom site and instrument, and the relationship between Sondrestrom and the other AF sites. We also established the importance of this site by describing its geophysically unique features. Finally, some of the first measurements from Sondrestrom are presented, and interpreted in terms of high latitude features. GRA

**N91-20585#** Rome Univ. (Italy).
**PRELIMINARY RESULTS ON MEASUREMENTS OF THE INTERACTION OF A DYNAMICAL GRAVITATIONAL NEAR FIELD WITH A CRYOGENIC GRAVITATIONAL WAVE ANTENNA**
R. Bizzarri, R. Cardarelli, A. Degasperis, D. DePedis, G. Muratori, G. V. Pallottino, C. Patrignani, G. Pizzella, M. Price, and F. Ricci (Istituto Nazionale di Fisica Nucleare, Rome, Italy ) 16 Jul. 1990 31 p
(Nota-Interna-953; ETN-91-98875) Avail: NTIS HC/MF A03

Evaluation and measurement of the effect of the gravitational field generated by a small rotating quadrupole on the Explorer 2270 kg cryogenic gravitational wave antenna of the Rome group is reported. The induced signal has an amplitude twenty times larger than the detector noise when the antenna was equipped with an FET (Field Effect Transistor) amplifier. The signal is easily detected without requiring integration in time. Using this method, absolute calibration of a gravitational wave antenna is achieved. ESA

**N91-20586*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**THE MAGSAT BIBLIOGRAPHY. REVISION 1**
R. A. Langel, B. J. Benson, and R. M. Orem (ST Systems Corp., Lanham, MD.) Feb. 1991 110 p
(NASA-TM-104534; Rept-91B00063; NAS 1.15:104534) Avail: NTIS HC/MF A06 CSCL 08G

Publications related to the Magsat project number 402, as of February 1991 are presented. Of these, 44 deal with analysis of the Earth's main magnetic field, 209 deal with analysis of the Earth's crustal field, 43 make use of Magsat-based main field models, and 63 deal with analyses of the magnetic field originating external to the Earth. The remainder documents the Magsat program, satellite, instruments, or data, or are review papers or books which use or refer to Magsat and its data. The Bibliography is divided into two parts; the first lists all papers by first author, and the second is subdivided by topic. Author

# 47 METEOROLOGY AND CLIMATOLOGY

Includes weather forecasting and modification.

**N91-20587#** Federal Aviation Administration, Atlantic City, NJ.
**REAL-TIME WEATHER PROCESSOR (RWP) PROTOTYPE TEST AND EVALUATION (PT AND E) EVALUATION REPORT**
Elizabeth Turcich, Thomas Gulley, Richard Mitchem, and Alanna Randazzo Mar. 1991 275 p
(DOT/FAA/CT-TN90/51) Avail: NTIS HC/MF A12

The Real-Time Weather Processor (RWP) is a data processing subsystem that will provide hazardous and operationally significant weather information for use by National Weather Service (NWS) Center Weather Service Unit (CWSU) meteorologists, Air Traffic Control Specialists (ATCSs), pilot, and other users. The results of the user evaluation portion of the Prototype Test and Evaluation (PT and E) of the RWP Prototype are detailed. The user evaluation was conducted at JPL during the month of July. Both NWS CWSU meteorologists and Federal Aviation Administration (FAA) Air Route Traffic Control Center (ARTCC) system maintainers participated in the evaluation. The results of the evaluation showed that overall, the system was rated as acceptable but that there were areas that require improvement; i.e., complex man-machine interface, system response too slow, and problems with the direct command language (DCL). The evaluation results were presented to the RWP Program Office for consideration. Author

**N91-20588#** National Severe Storms Forecast Center, Kansas City, MO.
**VERIFICATION OF SEVERE LOCAL STORM FORECASTS ISSUED BY THE NATIONAL SEVERE STORMS FORECAST CENTER: 1989**
Preston W. Leftwich, Jr. and Richard W. Anthony Sep. 1990 16 p
(PB91-129056; NOAA-TM-NWS-NSSFC-28) Avail: NTIS HC/MF A03 CSCL 04B

The Severe Local Storm (SELS) Unit of the National Severe Storms Forecast Center routinely issues convective outlooks and severe local storm watches to delineate areas that are favorable for development of severe local storms. The verification of those forecasts that were issued during 1989 is summarized. The threat of SELS's was identified well via the second-day outlooks. Prediction of the location of subsequent events improved in the first-day outlooks. During 1989, 88 percent of the tornado-related fatalities and 85 percent of the tornado-related injuries occurred within valid SELS watches. GRA

**N91-20589*#** North Carolina State Univ., Raleigh. Dept. of Marine, Earth, and Atmospheric Sciences.
**AN INVESTIGATION OF THE DETECTION OF TORNADIC THUNDERSTORMS BY OBSERVING STORM TOP FEATURES USING GEOSYNCHRONOUS SATELLITE IMAGERY Final Report**
Charles E. Anderson 1 Jan. 1991 5 p
(Contract NAS8-38135)
(NASA-CR-184126; NAS 1.26:184126) Avail: NTIS HC/MF A01 CSCL 04B

The number of tornado outbreak cases studied in detail was increased from the original 8. Detailed ground and aerial studies were carried out of two outbreak cases of considerable importance. It was demonstrated that multiple regression was able to predict the tornadic potential of a given thunderstorm cell by its cirrus anvil plume characteristics. It was also shown that the plume outflow intensity and the deviation of the plume alignment from storm relative winds at anvil altitude could account for the variance in tornadic potential for a given cell ranging from 0.37 to 0.82 for linear to values near 0.9 for quadratic regression. Several predictors were used in various discriminant analysis models and in censored regression models to obtain forecasts of whether a cell is tornadic and how strong tornadic it could be potentially. The experiments were performed with the synoptic scale vertical shear in the horizontal wind and with synoptic scale surface vorticity in the proximity of the cell. Y.S.

**N91-20590#** World Meteorological Organization, Geneva (Switzerland).
**PROCEEDINGS OF THE 5TH PLANNING MEETING ON WORLD CLIMATE PROGRAMME-WATER**
May 1990 99 p Meeting held in Laxenburg, Austria, 30 Apr. - 4 May 1990
(WCAP-11; WMO/TD-374) Avail: NTIS MF A05

Papers presented at the Fifth Planning Meeting on the World Climate Programme-Water are compiled. The following subject areas are covered: review of recommendations and decisions of

governing and advisory bodies; general review of current and planning activities; implementation of WCP-Water projects; plans for the second World Climate conference; and future developments and medium- to long-term plans. Y.S.

**N91-20591#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
**A STUDY OF DRY MICROBURST DETECTION WITH AIRPORT SURVEILLANCE RADARS**
M. A. Meister 29 Nov. 1990 53 p
(Contract DTFA01-83-4-10579)
(AD-A230060; ATC-176; DOT/FAA/NR-90/5) Avail: NTIS HC/MF A04 CSCL 04/2

This report evaluates the capability of Airport Surveillance Radars (ASRs) for the detection of low altitude wind shear associated with the outflows of dry microbursts. It describes results of simulations of dry microburst observations by the ASR. These simulations incorporated weather and clutter data collected by the FL-2 pencil-beam Doppler weather radar at Denver Stapleton Airport in 1988 and 1989 and clutter data collected by the FL-3 ASR-9 emulation radar at Huntsville, Alabama. The impact of signal strength, overhanging precipitations, and ground clutter on both observability and algorithmic performance are assessed. Principal results of study are the following: (1) Overhanging precipitation and weak signal strength do not, by themselves, prohibit detection of dry outflows; however, occurrence of false alarms and biases in velocity estimates indicate that improvements in the dual beam estimator that was evaluated would be required for reliable detection of these events. (2) Ground clutter tends to obscure dry outflows in regions where the difference between median effective clutter reflectivity and weather reflectivity exceeds 17 to 20 dB. A method for predicting the percentage of missed microburst detections due to ground clutter is used to estimate overall microburst detection probabilities for a dry environment such as Denver. Using simulated Denver clutter, overall detection probability is 91 percent. GRA

**N91-20592#** Lowell Univ., MA. Dept. of Earth Science.
**SUPER-MICRO COMPUTER WEATHER PREDICTION MODEL**
Frank P. Colby, Jr. and Keith L. Seitter Jun. 1990 75 p
(Contract F19628-88-K-0016)
(AD-A230063; GL-TR-90-0174; SR-2) Avail: NTIS HC/MF A04 CSCL 04/2

A meso-beta scale model is being developed to provide forecast guidance in the 3 to 18 h time period. The model is intended for use at local base weather offices equipped with a super-mirco class computer, allowing these offices to produce local forecast guidance for their region. The model consists of five layers, the lowest of which represents the evolving boundary layer. A specially developed vertical coordinate is used that allows the model to dynamically adjust to changes in boundary-layer height so that the thickness of the lowest layer increases and decreases as the boundary layer grows and shrinks. This allows a fairly simple boundary-layer parameterization to be used that realistically simulates boundary-layer processes. This report presents the model equations for the dynamic model, including their derivation and energy conserving finite difference representation. The physical parameterizations were presented in an earlier report, so only changes compared to that previous presentation are included here. This report also presents the results from a variety of test simulations of the model and physical parameterizations.
Author (GRA)

**N91-20593#** Naval Postgraduate School, Monterey, CA.
**BOUNDARY LAYER STRUCTURE OF AN EXPLOSIVE CYCLONE M.S. Thesis**
Glen D. Steeley Mar. 1990 35 p
(AD-A230296) Avail: NTIS HC/MF A03 CSCL 04/2

A detailed analysis of the horizontal boundary layer structure of the warm front of an open ocean explosive cyclone in Intensive Observation Period (IOP) 2 of the Experiment on Rapidly Intensifying Cyclones in the Atlantic (ERICA) is conducted. Data for this study consists of aircraft data averaged over one minute supplemented by satellite and drifting buoy observations. Analysis of surface winds and fluxes was done using the Brown-Liu Marine PBL model. Results show a PBL which differs from that found in typical cyclones, with large latent heat fluxes south of the warm front and with relatively weak sensible heat fluxes about the warm front. Boundary layer stratification was stable north of the warm front and unstable south of the warm front. A mechanism for moist frontogenesis is proposed whereby the destabilizing effects of the latent heat flux enhances frictional convergence along the warm front. These fluxes warm and moisten the cyclone's warm sector, enhancing unstable convection along the warm front and thereby enhancing the vertical motion. This enhanced vertical motion would strengthen the geostrophic deformation of the theta sub epsilon gradient and potentially enhance cyclogenesis. GRA

**N91-20594#** Naval Postgraduate School, Monterey, CA.
**OPTICAL TURBULENCE AND RAWINSONDE MEASUREMENTS FOR 17-28 SEPTEMBER 1989 AT ANDERSON MESA/UNITED STATES NAVAL OBSERVATORY, FLAGSTAFF, ARIZONA**
Gail T. Vaucher, Christopher A. Vaucher, and Donald L. Walters 27 Jun. 1990 107 p
(AD-A230310; NPS61-90-005PR) Avail: NTIS HC/MF A06 CSCL 04/2

The Naval Postgraduate School Atmospheric Optics Group acquired atmospheric optical turbulence and navaid radiosonde (rawinsonde) data in the Flagstaff, Arizona region as part of a site survey for a large-scale, ground-based, synthetic aperture system (100 to 300 m baseline stellar interferometer). From 17 to 25 September 1989, measurements were taken from the Lowell Observatory 31-inch telescope dome facility on Anderson Mesa, 16 km southeast of Flagstaff. Further sampling occurred 26 to 28 September 1989 from the United States Naval Observatory's (USNO) 61-inch telescope dome, approximately 8 km west of Flagstaff. The parameters measured consisted of transverse coherence lengths, isoplanatic angles, and various meteorological surface and upper-air variables measured from a high resolution, instrumented balloon (rawinsonde) system. This report compiles, analyses and summarizes the acquired data. A summary of the synoptic scale activities occurring simultaneously over the data acquisition sites is also presented. GRA

**N91-20595#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
**CLUTTER REJECTION FOR DOPPLER WEATHER RADARS WITH MULTIRATE SAMPLING SCHEMES**
M. H. Goldburg 11 Dec. 1990 132 p
(Contract DTFA01-L-83-10579)
(AD-A229762; ATC-149) Avail: NTIS HC/MF A07 CSCL 04/2

Reliable weather parameter estimates are required of radars such as the Terminal Doppler Weather Radar (TDWR) which will automatically detect hazardous weather phenomena in the vicinity of an airport. Velocity and range aliasing will degrade the quality of these estimates, as will contamination by ground clutter. For radars which operate at short ranges and at low elevation angles, as the TDWR will to detect windshears at the airport surface, clutter contamination is an especially severe problem. Multirate pulse trains can extend both the unambiguous velocity and range of a Pulsed Doppler Radar beyond those afforded by pulse trains with a constant intersample spacing; but the usual properties of conventional clutter filter architectures change radically when applied to data collected with a multirate sampling scheme. The Pulse-Pair spectral moment estimators are presented, followed by a discussion of frequency domain clutter rejection techniques for Batch PRT (Pulse Repetition Time) sequences. The main topic of the report is clutter suppression for Staggered PRT sequences in which the PRT alternates from pulse to pulse. The Staggered PRT scheme has the advantage over the Batch PRT scheme of spatial coherency for estimates of the radar return signal's autocorrelation function at the lags corresponding to the two PRT's. A time varying filter architecture with multiple transfer functions is presented and analyzed, and its interaction with the Pulse Pair estimators is explored. GRA

**N91-20596*#** Texas A&M Univ., College Station. Dept. of Meteorology.
**ANALYSIS OF ENERGY BALANCE MODELS USING THE ERBE DATA SET Final Report**
Charles E. Graves and Gerald R. North 3 Apr. 1991 10 p
(Grant NAG1-1062)
(NASA-CR-188002; NAS 1.26:188002) Avail: NTIS HC/MF A02 CSCL 04B

A review of Energy Balance Models is presented. Results from the Outgoing Longwave Radiation parameterization are discussed. The albedo parameterizations and the consequences of the new parameterizations are examined. Y.S.

**N91-20597#** North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.
**CYCLONE PERFORMANCE AND OPTIMIZATION**
D. Leith 15 Dec. 1990 33 p
(Contract DE-FG22-87PC-79922)
(DE91-008440; DOE/PC-79922/T6) Avail: NTIS HC/MF A03

An empirical model for predicting pressure drop across a cyclone, developed by Dirgo (1988), is presented. The model was developed through a statistical analysis of pressure drop data for 98 cyclone designs. This model is used with the efficiency model of Iozia and Leith (1990) to develop an optimization curve which predicts the minimum pressure drop on the dimension ratios of the optimized cyclone for a given aerodynamic cut diameter, d(sub 50). The effect of variation in cyclone height, cyclone diameter, and flow on the optimization is determined. The optimization results are used to develop a design procedure for optimized cyclones. DOE

**N91-20598*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**A SIMPLIFIED TREATMENT OF SiB'S LAND SURFACE ALBEDO PARAMETERIZATION**
Randal D. Koster and Max J. Suarez Apr. 1991 14 p
(NASA-TM-104538; Rept-91A01312; NAS 1.15:104538) Avail: NTIS HC/MF A03 CSCL 04B

The earlier presented surface albedo parameterization is simplified by assuming that the reflectance of direct solar radiation is a simple function of solar zenith angle. The function chosen contains three parameters that vary with vegetation type, greenness, and leaf area index. Tables of parameter values are presented. Using these tables, SiB's (Simple Biosphere model) absorbances of direct solar radiation can be reproduced with an average relative error of less than 0.5 percent. Finally, the direct reflectance function is integrated over zenith angle to produce an equation for the surface reflectance of diffuse radiation. Y.S.

# 48 OCEANOGRAPHY

Includes biological, dynamic, and physical oceanography; and marine resources.

For related information see also *43 Earth Resources and Remote Sensing.*

**N91-20599#** Washington Univ., Seattle. School of Oceanography.
**THE FIRST DIRECT MEASUREMENTS OF UPPER OCEANIC CRUSTAL COMPRESSIONAL WAVE ATTENUATION Final Report**
Randall S. Jacobson and B. T. Lewis 1990 14 p
(Contract N00014-84-C-0111)
(AD-A229902) Avail: NTIS HC/MF A03 CSCL 08/3

The first direct measurement of compressional wave attenuation of the uppermost 650 m of oceanic crust was performed using data recorded by seafloor hydrophones and large (56 to 116 kg), deep, explosive sources. The site was 13 km east of the southernmost Juan de Fuca Ridge on crust 0.4 m.y. old. Spectral ratios were performed between bottom refracting waves and direct water waves, adjusted for spreading losses and transmission coefficient losses. Several tests of the data were performed, demonstrating that attenuation is linearly related to frequency between 15 and 140 Hz, but frequency-independent components of attenuation are also evident. Values of compressional wave Q clusters between 20 and 50 and do not show any systematic variation with depth over 650 m. The attenuation results also indicate the presence of heterogeneities within the crust, as the solutions for each receiver's data set are significantly different. No evidence for azimuthal variations of attenuation are supported by the data, although the data do not optimally sample a wide variation of azimuths. The attenuation values are judged to be normal to higher than expected for the whole oceanic crust, based upon comparisons to results from synthetic seismogram modeling by others and by modeling signal to noise ratios of typical seismic refraction profiles. The results are consistent with recent laboratory measurements at ultrasonic frequencies for dry and saturated basalts at seafloor pressures and temperatures. GRA

**N91-20600#** Louisiana State Univ., Baton Rouge. Dept. of Computer Science.
**A TECHNIQUE FOR FEATURE LABELING IN INFRARED OCEANOGRAPHIC IMAGES**
N. Krishnakumar, S. Iyengar, Ron Holyer, and Matthew Lybanon 1989 9 p
(Contract N00014-88-K-6002)
(AD-A229909; NOARL-PR-89-003-321) Avail: NTIS HC/MF A02 CSCL 08/3

Thermal infrared images of the ocean obtained from satellite sensors are used for the study of ocean dynamics. Mesoscale ocean information from satellite data depends to a large extent on the correct interpretation of infrared oceanographic images. The difficulty of the image analysis and understanding problem for oceanographic images is due in part to a lack of precise mathematical descriptions coupled with the time varying nature of these features and the complication that the view of the ocean surface is typically obscured by clouds. A technique is described that uses a nonlinear probabilistic relaxation method for the oceanographic feature labeling problem. A unified mathematical framework that helps solve the problem is presented. The advantages are given of using contextural information in the feature labeling algorithm. This technique makes use of an efficient edge detection algorithm based on cluster shaded texture measure. This algorithm is more suitable for labeling the mesoscale features. Results are presented of experiments conducted at Remote Sensing Branch. Author

**N91-20601#** Quadrant Engineering, Inc., Amherst, MA.
**FINE SCALE MEASUREMENTS OF MICROWAVE BACKSCATTER FROM THE OCEAN SURFACE Final Report**
James B. Mead 1990 49 p
(Contract N00014-90-C-0108)
(AD-A229954) Avail: NTIS HC/MF A03 CSCL 17/9

Background information necessary to understand the operation of the radar includes a review of the radar range equation for short pulse-radars and basic sampled array theory. A detailed description of the proposed X-Band focused array system is given. Also included are predictions of signal-to-noise ratio as a function of range, and discussion of the data acquisition system. A processing algorithm was used to simulate the response of the proposed system to a hypothetical tilt modulated ocean surface. This software was used as a design tool in evaluating the proposed radar, but may also serve as the core of a processing algorithm used in processing actual data. Simulations are presented of the response of the radar to point targets at several signal-to-noise levels. The last chapter discusses how such a system might be used in applications of interest to oceanographers and others interested in interactions of electromagnetic radiation with the ocean surface. An obvious application is to study backscatter as a function of ocean sea state. In particular, the ability to degrade azimuthal and range resolution in software will allow the dependence of backscattering statistics on pixel size to be studied. The issue of what mechanism causes waves to appear in SAR generated ocean images may also be studied experimentally with this radar. GRA

**N91-20602#** Naval Ocean Research and Development Activity, Bay Saint Louis, MS.
**QUALITY CONTROL ALGORITHMS FOR OCEAN TEMPERATURE DATA Final Report**
Patricia A. Phoebus Mar. 1990 29 p
(AD-A229984; NORDA-243) Avail: NTIS HC/MF A03 CSCL 08/3

The Fleet Numerical Oceanography Center (FNOC) provides daily analyses of the 3-D ocean thermal structure both at the fleet and at regional oceanography centers around the world. These analyses are performed on both hemispheric and regional scale grids, with resolutions as fine as 20 km in some areas. The Remote Sensing Branch of the Naval Ocean Research and Development Activity (NORDA) has been involved in assessing the impact of multichannel sea surface temperatures (MCSSTs) on these ocean thermal analyses. Specifically, NORDA has worked closely with FNOC in developing the Optimum Thermal Interpolation System (OTIS). NORDA'S primary interest was to assure that the MCSSTs were properly utilized to detect and analyse mesoscale ocean fronts and eddies, with particular attention paid to how the MCSSTs were assimilated with other types of data. Through this joint effort, FNOC has successfully implemented OTIS as the operational ocean thermal analysis system for the global analysis and the Gulf Stream regional analysis. In addition to processing and assimilating data from various sources, OTIS includes quality control algorithms to automatically make decisions about the quality of the observations and to ignore data that are apparently erroneous. GRA

**N91-20603#** Naval Oceanographic and Atmospheric Research Lab., Bay Saint Louis, MS.
**CLASSIFICATION OF UNDERWATER ACOUSTIC TRANSIENTS BY ARTIFICIAL NEURAL NETWORKS**
Ronald L. Greene and Robert L. Field 1990 2 p
(AD-A230081) Avail: NTIS HC/MF A01 CSCL 17/1

Artificial neural networks have been trained using the backpropagation algorithm to classify a variety of model transient source signals. The networks were then tested on signals propagated to 25 different receiver sites by the time-domain parabolic equation model. Despite the interference effects from surface and bottom reflections, the classification accuracy is about 90 percent in the noise-free case, virtually identical to that of a nearest-neighbor classifier on the same problem. Classification in the presence of noise is considerably reduced; however, the redundancy provided by the multiple receivers in most cases allows the network to correctly classify all signals from sources on which it was trained. In addition, it shows a robustness in the presence of unknown signals not shown by the nearest-neighbor classifier. GRA

**N91-20604#** Scripps Institution of Oceanography, La Jolla, CA. Marine Physical Lab.
**DIGITAL, ONE WAY, ACOUSTIC COMMUNICATION IN THE OCEAN Ph.D. Thesis**
Amos A. Dotan Sep. 1990 165 p
(Contract N00014-88-K-2040)
(AD-A230171; SIO-REF-90-30) Avail: NTIS HC/MF A08 CSCL 08/3

This dissertation summarizes the work done on developing methods for underwater telemetry, between two freely drifting stations, in the presence of a slowly time-varying, frequency-selective fading channel and strong multipath. At sea experiments conducted during 1989 to 1990 show that the acoustic communication channel suffers from strong frequency-selective fading and strong multipath on the order of seconds. Moreover, most of the time, the intensity of the received signal due to the first multipath is much stronger than the received direct signal. In order to establish a reliable communication channel in the presence of strong fading, diversity must be used. DPSK chirp modulation proved to be superior over all other frequency diversity methods. Moreover, it is shown that a chirp QDPSK with bandwidth expansion of 5 has better performance than a combination of an error correcting code and frequency diversity method with similar bandwidth expansion. The achieved bit error rate when a chirp DPSK is used in the presence of frequency selective fading is the same as that of a conventional DPSK modulation in the presence of AWGN. Both bit synchronization and equalization methods which take into consideration the multipath and fading effects, are proposed. The major problem with bit synchronization is the destructive effect of the micromultipath that causes large time jitter. GRA

# 51 LIFE SCIENCES (GENERAL)

**N91-20605#** Baylor Coll. of Medicine, Houston, TX. Div. of Neuroscience.
**A STUDY OF NEURONAL PROPERTIES, SYNAPTIC PLASTICITY, AND NETWORK INTERACTIONS USING A COMPUTER RECONSTITUTED NEURONAL NETWORK DERIVED FROM FUNDAMENTAL BIOPHYSICAL PRINCIPLES Semiannual Progress Report, Dec. 1989 - Jun. 1990**
David C. Tam 14 Jun. 1990 5 p
(Contract N00014-90-J-1353)
(AD-A230476; BCM-NS-CNS-90-001) Avail: NTIS HC/MF A01 CSCL 02/5

The computer models simulating the biophysical properties of neurons are being implemented on the Macintosh IIci computer. The coding of the neural simulator programs MacNeuron and MacNerveNet have initiated. The software has gone through the design phase, and is now in the development phase. Based on careful analysis, the design decision was made to implement the neural simulators using object-oriented programming language over the traditional procedural programming language. The choice of Object Pascal language will facilitate future adaptation and modification of the simulators to incorporate newly discovered biophysical properties of neurons in the model without extensively re-writing the programs. Since object-oriented codes are modular in design, the program can also implement the plastic changes of synaptic substrates in a well structured organization. The various membrane ionic channels are implemented as objects in the same class, which have similar but unique (biophysical) properties. Thus, a class library can be created to form a collection of different ionic conductance channels, were new (user-specified) channels can be added to the class library. They can be incorporated into the neural simulators easily using the inheritance-properties of superclass and subclass provided by object-oriented languages. Modules of the programs are written representing the internal structure of the neural models. GRA

**N91-20606#** Baylor Coll. of Medicine, Houston, TX. Div. of Neuroscience.
**A STUDY OF NEURONAL PROPERTIES, SYNAPTIC PLASTICITY, AND NETWORK INTERACTIONS USING A COMPUTER RECONSTITUTED NEURONAL NETWORK DERIVED FROM FUNDAMENTAL BIOPHYSICAL PRINCIPLES Semiannual Progress Report, Jun. - Dec. 1990**
David C. Tam 14 Dec. 1990 6 p
(Contract N00014-90-J-1353)
(AD-A230477; BCM-NS-CNS-90-002) Avail: NTIS HC/MF A02 CSCL 12/5

The neural simulator program MacNeuron is currently implemented on the Macintosh IIci computer with executable versions using either the Motorola 68020 or 68000 processor and with or without the Motorola 68881 math co-processor. A preliminary version of the program showing some features of the user-interface compiled with the 68020/68881 options is included with the progress report. A preliminary user manual is also included which describes the execution environment of the program. Currently, the program consists of more than 15,000 lines of Pascal code, and the program is still in its development and testing stages where more codes will be generated and modified. The program is written in Object Pascal using the THINK Pascal compiler incorporating the class-structure of the THINK Class library for building the neuron-class structure. Since substantial efforts have

been put into designing a generalized generic neuronal stimulator for realistic neuron simulation, it becomes more apparent that the same simulation program can encapsulate the similar structure of an integrate-and-fire reduced model of the MacNerveNet into one single hybrid model program as envisioned in the original grant proposal is taken into account in the design of the MacNeuron program. Independent efforts to develop the MacNerveNet program has been re-directed to incorporate the program into MacNeuron to maximize the program development results. GRA

**N91-20607#** Federal Aviation Administration, Washington, DC. Office of Aviation Medicine.
**INHALATION TOXICOLOGY 10 TIMES TO INCAPACITATION FOR RATS EXPOSED CONTINUOUSLY TO CARBON MONOXIDE, ACROLEIN, AND TO CARBON MONOXIDE-ACROLEIN MIXTURES**
Charles R. Crane, Donald C. Sanders, and Boyd R. Endecott Dec. 1990 26 p
(AD-A230639; DOT/FAA/AM-90/15) Avail: NTIS HC/MF A03 CSCL 06/11

Laboratory rats were exposed to experimental atmospheres of the following: (1) carbon monoxide (CO) in air; (2) acrolein in air; and (3) mixtures of CO and acrolein in air. The toxic potency of each of the three types of environments was evaluated toxicokinetically by measurement of time-to-incapacitation, t(sub i), as a function of toxic gas concentrations. Regression equations were derived that relate the observed t(sub i)'s to the concentrations of individual gases. Comparison of the combined-gas-exposure data with results obtained from the individual gas exposures indicated that there was no evidence of synergistic action, i.e., that the effect of the combination was never greater than that predicted by the sum of the two individual gas effects. Evidence did exist for an inhibitory or antagonistic effect of undefined mechanism when acrolein was present in the mixture at concentrations of lesser toxic potency than that of CO. An empirical equation was derived that allows the calculation of a predicted t(sub i) for combinations of CO and acrolein concentrations within the ranges utilized in the experimental exposures. GRA

# 52 AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

**N91-20608*#** George Washington Univ., Washington, DC. Science Communication Studies.
**SPACE MEDICINE RESEARCH PUBLICATIONS: 1987-1988**
Feb. 1991 130 p
(Contract NASw-4324)
(NASA-CR-187840; NAS 1.26:187840) Avail: NTIS HC/MF A07 CSCL 06P

A list of publications of investigators supported by the Biomedical Research and Clinical Programs of the Life Sciences Division, Office of Space Science and Applications is given. Included are publications entered into the Life Sciences Bibliographic Database by the George Washington University as of 31 December 1988. Principal Investigators whose research tasks resulted in publication are identified by asterisk. Publications are organized into the following subject areas: space physiology and countermeasures (cardiopulmonary, musculoskeletal, neuroscience, and regulatory physiology), space human factors, environmental health, radiation health, clinical medicine, and general space medicine. Author

**N91-20609#** Duke Univ., Durham, NC. Div. of Allergy, Critical Care, and Respiratory Medicine.
**STRUCTURE OF THE GAS EXCHANGE REGION OF THE LUNGS DETERMINED BY THREE-DIMENSIONAL RECONSTRUCTIONS**
R. R. Mercer and J. D. Crapo 1990 30 p Submitted for publication Sponsored by Health Effects Research Lab., Research Triangle Park, NC
(Grant EPA-R-813113)
(PB91-133017; EPA/600/D-90/163) Avail: NTIS HC/MF A03 CSCL 06P

Data obtained from animal exposures may, if appropriately extrapolated, be used to assess quantitatively the health risks of humans chronically exposed to environmental airborne pollutants. The ability to make correct extrapolations is critical in making full use of the results of acute and chronic exposures in laboratory animals. Extrapolation of experimental results between different animal species requires several types of data, one of which is detailed data on the geometry of the lungs for each species, to determine the quantity of pollutant that reacts (or is deposited) in the various anatomic regions (trachea, bronchi, bronchioles, terminal bronchioles, proximal alveolar and distal alveolar regions). Data on the geometry of the lungs are almost exclusively concerned with the geometry of the major airways. The concentration of previous work on the major airways reflects the fact that they are the major determinants of airway resistance. GRA

**N91-20610#** Aerospace Medical Research Labs., Wright-Patterson AFB, OH.
**SUBJECTIVE RESPONSES TO POSITIVE PRESSURE BREATHING UNDER SUSTAINED HIGH-G USING THE COMBAT EDGE SYSTEM Final Report, Mar. - Aug. 1990**
Kathy McCloskey, Lloyd Tripp, Daniel W. Repperger, Stephen Popper, and Stephen Bolia Aug. 1990 60 p
(AD-A230019; AAMRL-TR-90-056) Avail: NTIS HC/MF A04 CSCL 06/5

The two studies reported here were conducted during the check-out phase of an assisted positive pressure breathing system, known as COMBAT EDGE, being developed by the U.S. Air Force. Manned centrifuge tests of the regulator which controls air pressure to the oro-nasal mask and counterpressure vest provided an early opportunity to obtain subjective data concerning systems characteristics from subjects under high-G. Subjects underwent four different high-G profiles: (1) +9Gz maximum (onset rate=0.1G/sec), (2) +5Gz maximum (onset rate=0.5 G/sec), (3) +7Gz maximum (onset rate=0.5 G/sec), and (4) +9Gz maximum (onset rate=0.5 G/sec). Onset of pressure to the mask and vest occurred at +4Gz with a rate of 12 mmHg/g. Maximum pressure was 60 mmHg at +9Gz. Subjects' reports of body pain mostly concerned the elbows and arms, followed by leg, ear, buttock, facial and rib pain. Subjects also reported that the M-1 and L-1 straining maneuvers were not needed as frequently with the COMBAT EDGE system. Tensing of the leg/buttock area was sufficient to counteract the effects of high-G. GRA

**N91-20611#** Federal Aviation Administration, Washington, DC. Office of Aviation Medicine.
**THE FAA ALTITUDE CHAMBER TRAINING FLIGHT PROFILE: A SURVEY OF ALTITUDE REACTIONS, 1965-1989**
Charles D. Valdez Sep. 1990 12 p
(AD-A230057; DOT/FAA/AM-90/12) Avail: NTIS HC/MF A03 CSCL 06/5

Reactions from 1,161 trainees out of 12,759 trainees subjected to the FAA altitude chamber training flights from 1965 to 1989 are annotated in this survey. Although there were some mild and expected reactions, these training profiles appear to provide a safe learning environment without compromising the student's health and safety. Inside chamber instructors did not fare as well, perhaps due to age and cumulative numbers of exposures, and recommendations are suggested for improved safeguards. GRA

**N91-20612#** Colorado State Univ., Fort Collins. Dept. of Physiology and Biophysics.
**THE PHOTOTOXICITY OF BLUE LIGHT ON THE FUNCTIONAL PROPERTIES OF THE RETINAL PIGMENT EPITHELIUM Final Technical Report, 1 May 1987 - 30 Sep. 1990**
E. L. Pautler 15 Oct. 1990 17 p
(Grant AF-AFOSR-0189-87; AF Proj. 2312)
(AD-A230072; AFOSR-90-1184TR) Avail: NTIS HC/MF A03 CSCL 06/10

Irradiation of the isolated bovine retinal pigment epithelium with 430 nm light at 20 mW/sq cm inhibited the unidirectional flux of leucine, glutamate and chloride in the retina to choroid direction; however, this intensity also produced discernible damage to the mitochondria. Reducing the level of radiation did not affect any of the transport systems studied. Ascorbate, morin, or vitamin E did not ameliorate the effect of blue light on transport, whereas melatonin did provide protection by forming an effective light filter. The combination of ethanol and exposure to blue light may constitute a health hazard for humans. Retina-derived factor(s) applied to the apical side of the preparation resulted in a stabilization of the TEP and SCC, followed by a secondary rise in both electrical parameters. These results lead to the hypotheses that the neural retina secretes a factor(s) which is essential for the regulation and maintenance of the RPE under normal physiological conditions and may facilitate repair processes in pathological states. GRA

**N91-20613#** Northeastern Univ., Boston, MA.
**CENTER FOR THE STUDY OF RHYTHMIC PROCESSES Annual Report, 1 Oct. 1988 - 31 Dec. 1989**
N. Kopell 1 Dec. 1990 10 p
(Contract F49620-87-C-0013)
(AD-A230166; AFOSR-90-1191TR) Avail: NTIS HC/MF A02 CSCL 06/4

The Center for the Study of Rhythmic Processes continued its work on Central Pattern Generators (CGPs), notably on the vertebrate spinal CPG for undulatory locomotion, and the invertebrate crustacean stomatogastric ganglion (STG). For the lamprey, a primitive vertebrate, experiments were designed and performed involving transduction of mechanical motion to neural activity; these experiments were combines with mathematical theory to help understand the relation of structure to function in that network. Other topics investigated included the effects of long coupling fibers, the relationship between muscle activation and movement, and the ability of the network to regenerate. Work on the STG included results on neuromodulators that change the output of the network and mathematical modelling of individual cells as well emergent properties of the network. GRA

**N91-20614#** Northeastern Univ., Boston, MA.
**CENTER FOR THE STUDY OF RHYTHMIC PROCESSES Final Report, 1 Oct. 1986 - 30 Apr. 1990**
N. Kopell 1 Dec. 1990 15 p
(Contract F49620-87-C-0013)
(AD-A230271; AFOSR-90-1190TR) Avail: NTIS HC/MF A03 CSCL 06/4

The Center for the Study of Rhythmic Processes began operation in the academic year 1986 to 1989 and was supported as a Center of Excellence through June 1990. The Center gathered together mathematicians and biologists to work on problems involving neural control of rhythmic motor behavior. There were two main problems addressed during this time. One was the structure and function of the intersegmental coordinating system of the vertebrate spinal cord, using the lamprey as the prototypic example. A broadly applicable mathematical framework was developed and applied. The major research Centers of the country working on this preparation were consolidated under the auspices of the Center. The new collaborations led to the design and performance of new experiments based on the mathematics. The second problem was the structure and function of small neural networks, such as the crustacean stomatogastric ganglion. Work was performed on tasks ranging from the biophysics of individual cells to emergent properties of the network. GRA

**N91-20615#** Naval Health Research Center, San Diego, CA.
**NAPPING, STIMULANT, AND FOUR CHOICE PERFORMANCE Interim Report**
Paul Naitoh, Tamsin L. Kelly, and Harvey Babkoff 14 Sep. 1990 35 p
(AD-A230366; NHRC-90-17) Avail: NTIS HC/MF A03 CSCL 06/5

The primary purpose of this paper is to determine whether a short sleep (nap) can maintain human cognitive functions during a long continuous work period. In continuous work environments, the normal 7 to 8 hour period of nocturnal sleep is not allowed. Instead, work continues in time periods longer than 24 hours. A long work period causes cognitive decrements due to fatigue and sleepiness. Can naps prevent such decrements? More specifically, can a sleep/wake schedule of a 20-min sleep every 6 hours prevent cognitive degradation during a continuous work period of 64 hours? The present chapter reports on the effects of the 20-min/340-min sleep/wake schedule on cognitive functions during a 64-hr work period. The 20/340 sleep/wake schedule was chosen for the study on the basis of previously published experimental studies. They suggest that short naps prevent cognitive decrements during a long continuous work period. GRA

**N91-20616#** Army Research Inst. of Environmental Medicine, Natick, MA.
**SUSTAINING HEALTH AND PERFORMANCE IN THE DESERT: ENVIRONMENTAL MEDICINE GUIDANCE FOR OPERATIONS IN SOUTHWEST ASIA Final Report**
J. F. Glenn, R. E. Burr, R. W. Hubbard, M. Z. Mays, R. J. Moore, and B. H. Jones 1 Dec. 1990 57 p
(AD-A229643; USARIEM-TN-91-1) Avail: NTIS HC/MF A04 CSCL 05/8

Southwest Asia (SWA) is a harsh and unfamiliar environment for American soldiers. SWA poses a set of hazards unfamiliar to most of the leaders and soldiers who have trained in the temperature and hygienically advanced environments of CONUS or Europe. The primary environmental hazard of SWA is the desert, which has a climate that spans from hot-dry to cold-damp depending on the season and time of day. Yet, there are also coastal areas featuring marshlands which increase the risk of cold injury during the winter. This technical note discusses the environmental hazards of SWA and how to deal with them. Armies have operated in SWA for thousands of years. Some have been successful and some have experienced disaster. An important difference between success and disaster has been the degree to which armies have stayed fit and healthy in the face of the disease and injury threats of SWA. GRA

**N91-20617#** New York Univ., New York. Center for Neural Science.
**HIGHER ORDER MECHANISMS OF COLOR VISION Technical Report, 15 Jun. 1989 - 14 Jun. 1990**
John Krauskopf 19 Nov. 1990 18 p
(Grant AF-AFOSR-0429-89; AF Proj. 2313)
(AD-A230448; AFOSR-90-1177TR) Avail: NTIS HC/MF A03 CSCL 06/4

This report covers our activities since June 15, 1989. The main accomplishments have been: (1) Completion and publication of a comprehensive study of the effects of chromatic content, blur and contrast of targets on vernier acuity and on stereo acuity; (2) The use of a new method of measuring chromatic discrimination under conditions of constant adaptation; (3) Continuation of the study of the chromatic properties of single cells in the monkey cortex, extending our experiments to Area V2; (4) Experiments on the significance of color in the perception of motion; (5) Experiments on the effects of chromatic adaptation on color matching; and (6) The effects of noise masks on the detection of chromatic and luminance pulses. GRA

**N91-20618#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**ESTIMATION OF EVOKED FIELDS USING A TIME-SEQUENCED ADAPTIVE FILTER WITH THE MODIFIED P-VECTOR ALGORITHM M.S. Thesis**
Jeffery A. Kepley Dec. 1990 182 p
(AD-A230474; AFIT/EN/GE/90D) Avail: NTIS HC/MF A09 CSCL 09/1

This theses describes a time sequenced adaptive filter developed to estimate visually evoked fields (EF) using visually evoked potentials (EP). These non-stationary signals are buried in strong background noise. The two types of noise are

magnetoencephalogram (MEG) and electronencephalogram (EEG). The filter implementation is based on the Ferrara Time Sequenced Adaptive (TSAF) using the Least-Mean-Square (LMS) algorithm and the Williams modified P-vector algorithm (mPa). This essentially results in two filters. A two stage filter structure is used in which the first stage removes the time-varying mean of the input signals. This allows the second stage to process zero-mean signals which increases the convergence speed of the filter. The theory for the two filters is overviewed with the input signals to the filters modelled as the sum of three uncorrelated components: average signal response, signal jitter, and noise. The signal model is verified based on a statistical analysis of simulated EP data files. The software implementation is then shown to be error free. GRA

**N91-20619#** California Univ., Irvine. Center for Neurobiology of Learning and Memory.
**SYNAPTIC PLASTICITY AND MEMORY FORMATION Annual Technical Report, 15 May 1989 - 14 May 1990**
Gary Lynch 5 Dec. 1990 9 p
(Grant AF-AFOSR-0383-89; AF Proj. 2312)
(AD-A230617; AFOSR-90-1217TR) Avail: NTIS HC/MF A02 CSCL 06/5

Studies were conducted on the induction, expression, and stabilization of long-term potentiation (LTP), a form of synaptic plasticity that is likely to participate in memory encoding. Induction was shown to involve a glycine receptor site that modulates calcium fluxes through a subclass of transmitter receptors. Other results indicated that LTP expression is not likely to involve release or changes in spine increased resistance, but did provide direct evidence that potentiation reflects a change in the conductance properties of post-synaptic receptors. The hypothesis was developed that stabilization of LTP involves a disconnection and reconnection of adhesive relationships that maintain the organization of the synaptic region. This involves a calcium sensitive protease that cleaves cytoskeletal proteins and the exposure of a group of adhesion receptors known as integrins. Together with results form previous years of support, and from other laboratories, work over the past year has led to a reasonable complete hypothesis concerning how synapses can be rapidly transformed from one stable state to another and thus be used as memory storage devices. GRA

**N91-20722*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**ANALYSIS OF THE INDIVIDUAL RISK OF ALTITUDE DECOMPRESSION SICKNESS UNDER REPEATED EXPOSURES**
K. Vasantha Kumar, David J. Horrigan, James M. Waligora, and John H. Gilbert (Space Biomedical Research Inst., Houston, TX.) *In its* Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 633-636 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 06P

## 53 BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

**N91-20620*#** George Washington Univ., Washington, DC. Science Communication Studies.
**SPACE HUMAN FACTORS PUBLICATIONS: 1980-1990**
Katherine J. Dickson Mar. 1991 14 p
(Contract NASw-4324)
(NASA-CR-4351; NAS 1.26:4351) Avail: NTIS HC/MF A03 CSCL 05I

A 10 year cummulative bibliography of publications resulting from research supported by the NASA Space Human Factors Program of the Life Science Division is provided. The goal of this program is to understand the basic mechanisms underlying behavioral adaptation to space and to develop and validate system design requirements, protocols, and countermeasures to ensure the psychological well-being, safety, and productivity of crewmembers. Subjects encompassed by this bibliography include selection and training, group dynamics, psychophysiological interactions, habitability issues, human-machine interactions, psychological support measures, and anthropometric data. Principal Investigators whose research tasks resulted in publication are identified by asterisk. Author

**N91-20621#** Federal Aviation Administration, Washington, DC. Office of Aviation Medicine.
**SELECTION OF AIR TRAFFIC CONTROLLERS FOR AUTOMATED SYSTEMS: APPLICATIONS FROM CURRENT RESEARCH**
Pamela S. DellaRocco, Carol A. Manning, and Hilda Wing Nov. 1990 38 p
(AD-A230058; DOT/FAA/AM-90/13) Avail: NTIS HC/MF A03 CSCL 05/9

Over the next two decades, the Federal Aviation Administration's (FAA) plan for new automated systems will change the air traffic control specialist's (ATCS) job as many of the current controller's tasks become automated. The purpose of this paper was to review the findings from current research on selection of ATCS's that may guide the design of selection systems for future controllers. To accomplish this two lines of research were presented: (1) projected changes in job tasks resulting from planned automation, and (2) the current ATCS selection system. A study completed in 1987 estimated that 48 of 337 job tasks of the enroute controller would be substantially changed with implementation of the Initial Sector Suites (ISSS). In light of the projected changes, the current selection system was evaluated in terms of the methodologies used for selection and the utility and validity of those methodologies. The current job is a highly complex set of tasks and demands high levels and active application of certain cognitive abilities, such as spatial perception, information processing, reasoning and decision making. Evaluation of the changes projected in the job over the next two decades suggested that a similar performance-based selection system could maintain utility through implementation of the ISSS. GRA

**N91-20622#** Naval Postgraduate School, Monterey, CA.
**LEARNING CURVE AND RATE ADJUSTMENT MODELS: COMPARATIVE PREDICTION ACCURACY UNDER VARYING CONDITIONS**
O. D. Moses Nov. 1990 40 p
(AD-A230075; NPS-AS-91-001) Avail: NTIS HC/MF A03 CSCL 05/3

Learning curve models have gained widespread acceptance as a technique for analyzing and forecasting the cost of items produced from a repetitive process. Considerable research has investigated augmenting the traditional learning curve model with the addition of a production rate variable, creating a rate adjustment model. This study compares the predictive accuracy of the learning curve and rate adjustment models. A simulation methodology is used to vary conditions along seven dimensions. Forecast errors are analyzed and compared under the various simulated conditions using ANOVA. Overall results indicate that neither model dominates; each is more accurate under some conditions. Conditions under which each model tends to result in lower forecast errors are identified and discussed. GRA

**N91-20623#** Human Resources Research Organization, Alexandria, VA.
**RESEARCH AND METHODS FOR SIMULATION DESIGN: STATE OF THE ART Final Report, Jan. 1985 - Dec. 1988**
Paul J. Sticha, Michael J. Singer, H. R. Blacksten, John E. Morrison, and Kenneth D. Cross Sep. 1990 187 p
(Contract MDA903-85-C-0169; DA Proj. 2Q2-63744-A-795)
(AD-A230076; HUMRRO-FR-PRD-88-27; ARI-TR-914) Avail: NTIS HC/MF A09 CSCL 05/9

The goal is to develop methods to help the training device designer perform the tradeoff analyses required for training device design. These methods should allow the designer to determine

the alternatives that meet training requirements at a minimum cost or provide the maximum training effectiveness at a given cost. The methods should apply to the 'concept formulation' phase of the training device development process and should be usable by the engineer responsible for developing the training device concept. The empirical results are reviewed along with analytical methods currently available that can be used to support the training device designer. This review addresses the problem of training system optimization in three ways. First, it describes existing methods that can aid training device design functions. The function and operation of these methods are compared to the model for the 'optimization of simulation based training systems' (OSBATS) developed for this project. Second, it reviews research on several issues related to training device optimization. The issues that are covered in the review include training device fidelity, instructional features, skill acquisition, skill retention, transfer of training, and cost estimation. Third, the review organizes the requirements for future research on these topics and sets priorities for research topics based on their cost and the benefit they could offer to the training device designer. GRA

**N91-20624#** Army Aeromedical Research Lab., Fort Rucker, AL.
**VISUAL SURVEY OF APACHE AVIATORS (VISAA) Final Report**
Isaac Behar, Roger W. Wiley, Richard R. Levine, Clarence E. Rash, and David J. Walsh Sep. 1990 75 p
(Contract USAARL-90-15; DA Proj. 3M1-62787-A-879)
(AD-A230201) Avail: NTIS HC/MF A04 CSCL 06/4

A three-part study was conducted to assess the visual status of AH-64 pilots. The first part consisted of an anonymous questionnaire returned by 58 Fort Rucker instructor pilots. More than 80 percent of the pilots registered at least one visual complaint (visual discomfort, headache, double vision, blurred vision, disorientation, or afterimages) associated with flying or after flying the Apache aircraft. Many of their comments indicated that symptoms occurred during long flights and/or flying with poor quality or out-of-focus display symbology. In the second part, a comprehensive visual functions test battery was completed on 10 volunteer, highly experienced AH-64 aviators. In the third part, measurements were made on the flight line of the Helmet Mounted Display diopter focus settings made by Apache IPs and students. The diopter settings ranged from 0 to -5.25 with a mean of -2.28. The required positive accommodation by the eye to offset these negative focus settings is very likely a source of visual discomfort and headache during and after long flights. GRA

**N91-20625#** Florida Univ., Gainesville. Dept. of Psychology.
**AUDITORY PATTERN MEMORY Final Report, 1 Oct. 1988 - 30 Sep. 1990**
Robert D. Sorkin 31 Oct. 1990 53 p
(Grant AF-AFOSR-0021-89; AF Proj. 2313)
(AD-A229743; AFOSR-90-1164TR) Avail: NTIS HC/MF A04 CSCL 05/8

Three studies of temporal pattern perception were conducted. The listener's task was to determine whether or not two arrhythmic, tonal sequences formed the same temporal pattern. The first study tested the Pattern Correlation model. According to this model, the listener estimates the correlation between the pattern of time intervals marked by the tones in each sequence. Listener performance was characterized by an internal noise that is dependent on the average time between marker tones. The second study tested the effects of temporally compressing or expanding the stimuli. The transformations are common in speech and music; an important feature of temporal pattern perception is the ability to recognize patterns as simular, despite such transformations. An additional internal noise, proportional to the magnitude of the difference between the pattern transformations, was postulated to describe performance. In the third study, the stimuli were present at different time delays and to separate earphone channels. At very short delays, waveform correlation is the likely comparison mechanism. At longer delays, pattern correlation is the probable mechanism, but this process is ineffective when the temporal patterns overlap. GRA

**N91-20626#** Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, OH.
**NEURAL NETWORK BASED HUMAN PERFORMANCE MODELING Final Report, Sep. 1988 - Sep. 1990**
Edward L. Fix Aug. 1990 138 p
(AD-A229822; AAMRL-TR-90-042) Avail: NTIS HC/MF A07 CSCL 06/5

Neural networks provide an alternative method of building models of human performance. They can learn behavior from examples, reducing the need for many identical repetitions and intensive analysis. A properly trained net can be very robust in its response to a novel stimulus. This opens the door to modeling performance in the presence of an interactive stimulus. Neural networks provide the possibility of robust models that can operate interactively in real time, depending on the size and architecture of the net and the application. A neural network architecture derived from recurrent back propagation is presented which learn to mimic human behavior and performance in a sample task. It shows operating characteristics similar to those of human subjects, and even makes the same kinds of mistakes. Possible application are discussed. GRA

**N91-20627#** Army Research Inst. for the Behavioral and Social Sciences, Alexandria, VA.
**AN ANNOTATED BIBLIOGRAPHY OF THE AIRCREW SELECTION LITERATURE Final Report, Oct. 1988 - May 1990**
David R. Hunter and Eugene F. Burke Sep. 1990 114 p
(AD-A230484; ARI-RR-1575) Avail: NTIS HC/MF A06 CSCL 05/9

This report summarizes the literature dealing with aircrew selection research conducted through 1989. It includes English language reports available from the open literature and from the United States, United Kingdom, and other armed services. Over 200 studies were identified using computer-assisted and manual searches of the bibliographic data bases and primary and secondary sources. These studies were categorized by the selection measure used. Summaries of the studies were provided. GRA

**N91-20628#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**ANALYSIS OF VISUAL ILLUSIONS USING GABOR FILTERS M.S. Thesis**
Richard A. Oberndorf Dec. 1990 150 p
(AD-A230678; AFIT/GE/ENG/90D-47) Avail: NTIS HC/MF A07 CSCL 06/4

This thesis has demonstrated the correctness of using spatial filters in the analysis of various visual illusions; the specific form of filter has been derived from a Gabor equation model of simple cell response on the visual cortex. The Gabor Low Pass Filter (GLPF) applied to these anomalies was derived from proposals made that simple cell response on the visual cortex may be modeled by a set of equations originally proposed by Gabor in the 1940's. Based upon the extension of these equations into two dimensions, a GLPF process was applied to computer-generated black and white illusions (the Kanizsa Triangle, the Spoked Circle and the Ehrenstein Illusion). The results demonstrate that the anomalous contour present in these illusions are explained by an energy boundary surrounding the anomalous area. These differing energies are a direct result of the GLPF process. Much work has been accomplished attempting to understand how and why the human brain perceives visual illusions. From a physiological viewpoint, the process of vision may be divided into two main operations. The first of these deals with the processing which takes place when light first enters the eye up to the point when this information reaches the visual cortex of the brain. The second area regarding the concept of vision is concerned with how the brain uses this data - the cognition and conceptual formulation which allows recognition of objects. GRA

**N91-20629#** Chicago Univ., IL. Center for Decision Research.
**A THEORY OF DIAGNOSTIC INFERENCE Final Report, 15 Feb. 1987 - 31 Jul. 1990**
Robin M. Hogarth Dec. 1990 30 p
(Contract N00014-84-C-0018)
(AD-A230703) Avail: NTIS HC/MF A03 CSCL 05/1

The central theme underlying this work is that complex judgments and choices result from simple psychological processes that interact with highly variable and complex environments. Thus, the research has been aimed at identifying such processes, describing them by parsimonious mathematical models, and testing their implications in experimental tasks. Three lines of research are described. These involve investigations concerning choice under conditions of risk, ambiguity, and ignorance; belief updating; and the effects of exactingness and incentives on the learning of repetitive decision making tasks. Here, exactingness means that the extent of the investigations follows a similar format: statement of issues motivating the research; specification of the model and psychological principles underlying the theoretical approach adopted; and summary of the main experimental results. GRA

# 54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

For related information see also *16 Space Transportation.*

**N91-20630*#** Space Station Engineering and Integration Contractor, North Olmsted, OH.
**AN ASSESSMENT OF THE SPACE STATION FREEDOM PROGRAM'S LEAKAGE CURRENT REQUIREMENT Final Report**
Michael Nagy Mar. 1991 16 p Prepared for NASA, Lewis Research Center, Cleveland, OH
(Contract NASw-4300)
(NASA-CR-187077; NAS 1.26:187077; PSL-450-RP91-003A)
Avail: NTIS HC/MF A03 CSCL 06K

The Space Station Freedom Program requires leakage currents to be limited to less than human perception level, which NASA presently defines as 5 mA for dc. The origin of this value is traced, and the literature for other dc perception threshold standards is surveyed. It is shown that while many varying standards exist, very little experimental data is available to support them. Author

**N91-20631*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**METHOD FOR OPTIMAL CONFIGURATION OF AN ECLSS ON THE SPACE STATION FREEDOM**
Marston J. Gould Feb. 1991 23 p
(NASA-TM-104040; NAS 1.15:104040) Avail: NTIS HC/MF A03 CSCL 06K

The establishment of a permanently manned Space Station represents a substantial challenge in the design of a life support system, specifically in the need to supply a large crew for missions of extended duration. The Space Station will evolve by time phased modular increments delivered and supplied by the Space Shuttle and other advanced launch systems. With the addition of each subsequent phase or alteration of mission duties, the requirements of the Station may differ from previous phases of development. With the addition of future crews and pressurized volume throughout the lifetime of the Space Station, change-out of individual subsystems may be necessary in order to meet the performance, safety, and reliability levels required from the Environmental Control and Life Support System (ECLSS). The analysis of this system growth demands the capability for advanced, integrated assessment techniques so that the unique mission drivers during each phase and mission scenario may be identified and evaluated. In order to determine the impacts of the interdependency between the ECLSS, the crew, the various user experiments, and the other distributed systems, consideration must be given to all Space Station resources and requirements during the initial and subsequent evolution phase. Therefore, it is necessary for analysis efforts to study the long term effects of established designs. These studies must quantify the optimal degree of loop closure within the capabilities of existing and future technologies including any resulting maintenance and logistics requirements. In addition, the necessity for subsystem retrofit during the lifetime of the Station must be examined. The source of system requirements due to long term exposure to the microgravity environment is illustrated, the criticality of the ECLSS functions is reviewed, and a method is described to develop an optimal design during each configuration based on the cross-consumption of Station resources. A comparison utilizing this procedure is discussed. Author

**N91-20632#** Vreuls Research Corp., Thousand Oaks, CA.
**HUMAN-COMPUTER INTERACTION IN TACTICAL OPERATIONS: DESIGNING FOR EFFECTIVE HUMAN-COMPUTER DIALOGUE Final Report, Jan. 1988 - Jul. 1990**
Richard W. Obermayer and Jon J. Fallesen Sep. 1990 86 p
(Contract MDA903-86-C-0210; DA Proj. 2Q1-62785-A-790)
(AD-A230069; ARI-RP-90-31) Avail: NTIS HC/MF A05 CSCL 23/2

This report presents guidelines for designing human-computer dialogue for tactical operations. Researchers consolidated sources of information into a form intended for use by designers of tactical computer systems to give them a basis to assess the military impact of dialogue design and take leadership in improving the usability of future systems. This report was developed to support dialogue design for two general situations: (1) the generation of specifications for relatively large-scale systems in which the specific design and development will be performed by another, and (2) the development of relatively small-scale special-purpose systems in which the reader will be the designer and developer, perhaps with the aid of a programmer. The user-computer dialogue is clearly the key to developing systems that fit in with user's goals and tasks. Consequently, this guide will emphasize the essence of the dialogue, clarification of fundamental issues, performance of front-end analyses, selection between alternative dialogue types, and testing for usability. This guide will not address (at least to any major degree) the issues of data display, contents of on-line documentation and help, data transmission, hardware devices, or general human engineering considerations. For those interested in reading further, a reading lis and a selected bibliography are provided. Author (GRA)

**N91-20633#** Army Research Inst. for the Behavioral and Social Sciences, Alexandria, VA.
**A META-ANALYTIC APPROACH FOR RELATING SUBJECTIVE WORKLOAD ASSESSMENTS WITH US ARMY AIRCREW TRAINING MANUAL (ATM) RATINGS OF PILOT PERFORMANCE Final Report, Jun. 1986 - Nov. 1989**
John E. Stewart, II and Ronald J. Lofaro Sep. 1990 27 p
(AD-A230127; ARI-TR-913) Avail: NTIS HC/MF A03 CSCL 01/3

In 1985 Lofaro, using a modified Delphi technique, had subject matter experts (SMEs) generate estimated ratings of the subjective workload imposed by various Aircrew Training Manual (ATM) tasks for several Army helicopters, including the UH-60 Blackhawk. For each task, ratio-scaled estimates of difficulty and time to perform were derived. This research was performed to determine the validity of the UH-60 ATM estimates by correlating them with instructor pilot (IP) ratings of checkride performance from two other unrelated research projects. The other efforts investigated the decay of ATM task-related skills among Reserve and regular Army aviators. A second phase of this project compared the difficulty ratings of ATM tasks associated with UH-60 accidents over FY 1980 to 1988 with those not associated with UH-60 accidents. A negative correlation between the modified Delphi weights assigned to ATM tasks and IP ratings on these tasks was hypothesized; the hypothesis was confirmed. Analysis of the UH-60 accident data confirmed the second hypothesis. GRA

**N91-20634#** BioTechnology, Inc., Falls Church, VA.
**HUMAN FACTORS ISSUES IN AIRCRAFT MAINTENANCE AND INSPECTION: INFORMATION EXCHANGE AND COMMUNICATIONS Final Report**
James F. Parker, Jr. and William T. Shepherd Nov. 1990 139 p
(AD-A230270; DOT/FAA/AM-90/14) Avail: NTIS HC/MF A07 CSCL 01/3

The Federal Aviation Administration sponsored a 2-day meeting in December 1989 as part of a continuing program to address issues of human factors and personnel performance in aviation maintenance and inspection. This meeting focused on issues of information exchange and communications. The primary goal was to consider means of ensuring that the exchange of information within the industry responsible for the maintenance of the U.S. air carrier fleet is accurate, efficient, and responsive to the particular needs of this industry. Presentations were given by representatives of commercial aviation interests and covered related efforts from other fields and new technologies having possible application to aviation maintenance. Each presentation was recorded and transcribed for purposes of study and publication. Eight recommendations were made to the Federal Aviation Administration regrading effective communications methodology among the various members of the maintenance industry. GRA

**N91-20635#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**A LOW-COST PART-TASK FLIGHT TRAINING SYSTEM: AN APPLICATION OF A HEAD MOUNTED DISPLAY M.S. Thesis**
David A. Dahn Dec. 1990 120 p
(AD-A230353; AFIT/GCE/ENG/90D-01) Avail: NTIS HC/MF A06 CSCL 01/2

To investigate the feasibility of using head-mounted display(HMD) and Computer Image Generators (CIG) in a low cost part-task trainer, we created a prototype system. Our approach was to build a virtual world interface using a HMD to an existing flight simulator application. This allowed a CIG with only one graphics channel to drive the display. To investigate which class of computing platform was suitable for use as the CIG, a cooperative thesis effort was launched to host the simulator on a mini-computer and micro-computer platform. The appropriate CIG could then be determined through demonstration and comparison between the systems. A software emulation library was built to transform the Silicon Graphics graphical reference model and function calls to the PC Reality PHIGS PLUS graphical reference model and function calls. This emulation allowed a nearly seamless interface to support porting the application program from the Silicon Graphics machine to the PC. GRA

**N91-20636#** Army Natick Labs., MA.
**AN ASSESSMENT OF LONG-TERM CHANGES IN ANTHROPOMETRIC DIMENSIONS: SECULAR TRENDS OF US ARMY MALES Final Report, Nov. 1988 - Jun. 1990**
Thomas M. Greiner and Claire C. Gordon Dec. 1990 72 p
(AD-A230416; NATICK/TR-91/006) Avail: NTIS HC/MF A04 CSCL 05/5

This report describes long-term changes in the body dimensions within the Army population for 22 body dimensions in four racial/cultural groups: Whites, Blacks, Hispanics and Asian/Pacific Islanders. Individuals were grouped by birth year into 12 five-year cohorts, which span the years 1911 to 1970. Rates of change were calculated by regressing age-adjusted dimensions against cohort. Analyses of these relationships showed that almost all dimensions sustained statistically significant linear trends, the few exceptions being found within the Asian/Pacific Islanders group. Furthermore, except for the Asian/Pacific Islanders, the greatest relative rates of change were found in dimensions related to soft tissue development rather than skeletal dimensions. This pattern is consistent with the most recent American cultural emphasis on health and physical fitness. The markedly different patterns seen in Asian/Pacific Islanders were best explained by immigration: they have experienced a linear increase in the proportion of foreign born members. GRA

**N91-20637#** Naval Health Research Center, San Diego, CA.
**BODY COMPOSITION IN MILITARY SERVICES: STANDARDS AND METHODS Final Report**
J. A. Hodgdon 28 Sep. 1990 19 p
(AD-A230435; NHRC-90-21) Avail: NTIS HC/MF A03 CSCL 05/9

This paper deals with two topics: The development of body composition standards in the U.S. Navy; and the methods of body composition assessment in use by the military Services today. In 1981, the Services were directed to develop body composition and fat standards consistent with the mission of the Services. Three concerns were outlined which dictated the establishment of weight control policy: (1) body composition was an integral part of physical fitness; (2) body composition is a determinant of appropriate military appearance; and (3) body composition is a determinant of general health and well-being of military personnel. Each of these three concerns was explored as a basis for setting standards for body composition in the Navy. Our investigations of relationships between body composition variables and performance of materials handling tasks suggest that percent body fat is not strongly related to such performance. Estimated fat-free mass, on the other hand, is highly correlated with strength and the ability to lift objects. GRA

**N91-20638#** Naval Postgraduate School, Monterey, CA.
**LATENT FACTOR MODELS AND ANALYSES FOR OPERATOR RESPONSE TIMES**
Donald P. Gaver and I. G. OMuircheartaigh Sep. 1990 67 p
(AD-A229675; NPS55-90-20) Avail: NTIS HC/MF A04 CSCL 12/3

Two models are presented for the response times of different operators to different tasks where response is initiated by one or more cues provided by the system. One model for the log-response times is a mixed or latent factor model with unequal case fixed effects and variances. The other model for the log-response times is a non-Gaussian log-extreme-value model. Procedures for estimating the parameters by maximum likelihood are presented. The models are used to analyze response time data from simulator experiments involving nuclear power plant operators performing certain safety-related tasks. The findings of the models are critiqued and applications to risk analysis are sketched. GRA

**N91-20639#** East Tennessee State Univ., Johnson City. Dept. of Physiology.
**ENHANCING THE TOLERANCE TO Gz(+) ACCELERATION BY OPTIMIZING THE USE OF ISOMETRIC CONTRACTIONS IN COMBINATION WITH STRAINING MANEUVERS Final Report, Oct. 1986 - Sep. 1987**
Carole A. Williams, J. Martin, J. Moffatt, J. E. Douglas, and A. R. Lind Aug. 1990 48 p
(Contract F33615-85-C-0530)
(AD-A230454; AAMRL-TR-90-044) Avail: NTIS HC/MF A03 CSCL 06/5

Experiments were performed on 9 male subjects who exerted L-1 straining maneuvers in a pilot chair apparatus with a seatback at 30 and a spine-to-thigh angle of 110. The L-1 maneuvers were performed with or without simultaneous application of isometric contractions. Contractions were exerted at high levels of force in either a sustained fashion or in an intermittent fashion, in 15 sec periods, until fatigue occurred. Isometric contractions were exerted by either the forearm flexors (handgrip), quadriceps, or jaw muscles at tensions of 70 percent MVC (handgrip, quadriceps) or 100 percent MVC (jaw). During the experiments, changes in arterial pressure, heart rate and electromyographic activity, from the intercostals and the contracting muscle group, were recorded. During the L-1 maneuver along, mean blood pressure (MBP) increased to 205 mmHg initially at the onset of the maneuver, but then fell by 50 mmHg, to 155 mmHg during the first 5 seconds of the procedure. The MBP recovered to 170 mmHg and remained at this level during the last 5 sec of the procedure. When isometric contractions were simultaneously applied, initial MBP were essentially the same as with the L-1 maneuver alone, but there was significantly higher MBP maintained throughout the remainder

of the L-1 procedure with the isometric contractions, such that MBP averaged almost 30 mmHg higher during the last 5 sec of the procedure. GRA

**N91-20640#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**REAL-TIME FLIGHT SIMULATION AND THE HEAD-MOUNTED DISPLAY: AN INEXPENSIVE APPROACH TO MILITARY PILOT TRAINING M.S. Thesis**
Philip A. Platt Dec. 1990 81 p
(AD-A230469; AFIT/GCS/ENG/90D-11) Avail: NTIS HC/MF A05 CSCL 12/5

The integration of the low-cost head-mounted display (HMD), an inexpensive graphics workstation-based flight simulator, and a communications network was investigated to determine if the prototype of an inexpensive multi-aircraft Virtual Flight Simulator could be built. Previous research efforts have coupled HMD technology and flight simulation; however, the cost of these systems has been high. This thesis effort emphasized the use of joystick devices to emulate pilot control, the implementation of a fully enclosed virtual flight simulator, and the utilization of low-cost television technology to produce a prototype. The virtual flight simulator also contained a basic set of instruments to help the pilot control the aircraft. The virtual world provided a full color 360 degree viewing capability which allowed the pilot to look around his aircraft and world. Although the display update rates of the final system were less than ideal, the results showed that the concept of virtual flight simulators has potential for improving the Air Force's overall pilot training capability. GRA

**N91-20683*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**INTELLIGENT MONITORING AND DIAGNOSIS SYSTEMS FOR THE SPACE STATION FREEDOM ECLSS**
Brandon S. Dewberry and James R. Carnes (Boeing Co., Huntsville, AL.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 338-343 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 05H

**N91-20703*#** Air Force Systems Command, Norton AFB, CA. Space Systems Div.
**A HUMAN FACTORS APPROACH TO RANGE SCHEDULING FOR SATELLITE CONTROL**
Cameron H. G. Wright and Donald J. Aitken *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 484-489 (For primary document see N91-20702 12-59)
(Contract F04701-86-C-0007)
Avail: NTIS HC/MF A14 CSCL 05H

**N91-20707*#** Oregon State Univ., Corvallis. Dept. of Industrial and Manufacturing Engineering.
**COCKPIT TASK MANAGEMENT: A PRELIMINARY, NORMATIVE THEORY**
Ken Funk *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 508-520 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 05H

**N91-20711*#** Ohio State Univ., Columbus. Cognitive Systems Engineering Lab.
**COGNITIVE CONSEQUENCES OF CLUMSY AUTOMATION ON HIGH WORKLOAD, HIGH CONSEQUENCE HUMAN PERFORMANCE**
Richard I. Cook, David D. Woods, Elizabeth McColligan, and Michael B. Howie *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 543-546 (For primary document see N91-20702 12-59)
(Contract NCC2-592)
Avail: NTIS HC/MF A14 CSCL 05H

**N91-20719*#** Lockheed Engineering and Sciences Co., Houston, TX.
**SPACECRAFT CREW PROCEDURES FROM PAPER TO COMPUTERS**
Michael ONeal and Meera Manahan *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 595-600 (For primary document see N91-20702 12-59)
(Contract NAS9-17900)
Avail: NTIS HC/MF A14 CSCL 05H

# 55 SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

No abstracts in this category.

# 59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL)

**N91-20641*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**FOURTH ANNUAL WORKSHOP ON SPACE OPERATIONS APPLICATIONS AND RESEARCH (SOAR 90)**
Robert T. Savely, ed. Washington Jan. 1991 495 p Workshop held in Albuquerque, NM, 26-28 Jun. 1990; sponsored by NASA, Washington, AF, and New Mexico Univ.
(NASA-CP-3103-Vol-1; S-618-Vol-1; NAS 1.55:3103-Vol-1) Avail: NTIS HC/MF A21 CSCL 12A

The proceedings of the SOAR workshop are presented. The technical areas included are as follows: Automation and Robotics; Environmental Interactions; Human Factors; Intelligent Systems; and Life Sciences. NASA and Air Force programmatic overviews and panel sessions were also held in each technical area. For individual titles, see N91-20642 through N91-20701.

**N91-20642*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**RESOLVED RATE AND TORQUE CONTROL SCHEMES FOR LARGE SCALE SPACE BASED KINEMATICALLY REDUNDANT MANIPULATORS c37**
Robert W. Bailey (LinCom Corp., Houston, TX.) and Leslie J. Quiocho *In its* Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 2-8 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

Resolved rate control of kinematically redundant ground based manipulators is a challenging problem. The structural, actuator, and control loop frequency characteristics of industrial grade robots generally allow operation with resolved rate control; a rate command is achievable with good accuracy. However, space based manipulators are different, typically have less structural stiffness, more motor and joint friction, and lower control loop cycle frequencies. These undesirable characteristics present a considerable Point of Resolution (POR) control problem for space based, kinematically redundant manipulators for the following reason: a kinematically redundant manipulator requires an arbitrary constraint to solve for the joint rate commands. A space manipulator will not respond to joint rate commands because of these characteristics. A space based manipulator simulation, including free end rigid body dynamics, motor dynamics, motor striction/friction, gearbox backlash, joint striction/friction, and

Space Station Remote Manipulator System type configuration parameters, is used to evaluate the performance of a documented resolved rate control law. Alternate schemes which include torque control are also evaluated. Author

**N91-20643*#** Teledyne Brown Engineering, Huntsville, AL.
**IVA THE ROBOT: DESIGN GUIDELINES AND LESSONS LEARNED FROM THE FIRST SPACE STATION LABORATORY MANIPULATION SYSTEM** **c37**
Carl R. Konkel, Allen K. Powers, and J. Russell Dewitt *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 9-14 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

The first interactive Space Station Freedom (SSF) lab robot exhibit was installed at the Space and Rocket Center in Huntsville, AL, and has been running daily since. IntraVehicular Activity (IVA) the robot is mounted in a full scale U.S. Lab (USL) mockup to educate the public on possible automation and robotic applications aboard the SSF. Responding to audio and video instructions at the Command Console, exhibit patrons may prompt IVA to perform a housekeeping task or give a speaking tour of the module. Other exemplary space station tasks are simulated and the public can even challenge IVA to a game of tic tac toe. In anticipation of such a system being built for the Space Station, a discussion is provided of the approach taken, along with suggestions for applicability to the Space Station Environment. Author

**N91-20644*#** New Mexico Univ., Albuquerque. Dept. of Mechanical Engineering.
**A NOVEL DESIGN FOR A HYBRID SPACE MANIPULATOR** **c37**
Mo Shahinpoor *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 15-22 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

Described are the structural design, kinematics, and characteristics of a robot manipulator for space applications and use as an articulate and powerful space shuttle manipulator. Hybrid manipulators are parallel-serial connection robots that give rise to a multitude of highly precise robot manipulators. These manipulators are modular and can be extended by additional modules over large distances. Every module has a hemispherical work space and collective modules give rise to highly dexterous symmetrical work space. Some basic designs and kinematic structures of these robot manipulators are discussed, the associated direct and inverse kinematics formulations are presented, and solutions to the inverse kinematic problem are obtained explicitly and elaborated upon. These robot manipulators are shown to have a strength-to-weight ratio that is many times larger than the value that is currently available with industrial or research manipulators. This is due to the fact that these hybrid manipulators are stress-compensated and have an ultralight weight, yet, they are extremely stiff due to the fact that force distribution in their structure is mostly axial. Actuation is prismatic and can be provided by ball screws for maximum precision. Author

**N91-20645*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**FORWARD AND INVERSE KINEMATICS OF DOUBLE UNIVERSAL JOINT ROBOT WRISTS** **c37**
Robert L. Williams, II *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 23-29 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

A robot wrist consisting of two universal joints can eliminate the wrist singularity problem found on many individual robots. Forward and inverse position and velocity kinematics are presented for such a wrist having three degrees of freedom. Denavit-Hartenberg parameters are derived to find the transforms required for the kinematic equations. The Omni-Wrist, a commercial double universal joint robot wrist, is studied in detail. There are four levels of kinematic parameters identified for this wrist; three forward and three inverse maps are presented for both position and velocity. These equations relate the hand coordinate frame to the wrist base frame. They are sufficient for control of the wrist standing alone. When the wrist is attached to a manipulator arm; the offset between the two universal joints complicates the solution of the overall kinematics problem. All wrist coordinate frame origins are not coincident, which prevents decoupling of position and orientation for manipulator inverse kinematics. Author

**N91-20646*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**PERFORMANCE CAPABILITIES OF A JPL DUAL-ARM ADVANCED TELEOPERATION SYSTEM** **c37**
Z. F. Szakaly and A. K. Bejczy *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 30-41 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

The system comprises: (1) two PUMA 560 robot arms, each equipped with the latest JPL developed smart hands which contain 3-D force/moment and grasp force sensors; (2) two general purpose force reflecting hand controllers; (3) a NS32016 microprocessors based distributed computing system together with JPL developed universal motor controllers; (4) graphics display of sensor data; (5) capabilities for time delay experiments; and (6) automatic data recording capabilities. Several different types of control modes are implemented on this system using different feedback control techniques. Some of the control modes and the related feedback control techniques are described, and the achievable control performance for tracking position and force trajectories are reported. The interaction between position and force trajectory tracking is illustrated. The best performance is obtained by using a novel, task space error feedback technique. Author

**N91-20647*#** Martin Marietta Space Systems, Inc., Denver, CO.
**SSSFD MANIPULATOR ENGINEERING USING STATISTICAL EXPERIMENT DESIGN TECHNIQUES** **c37**
John Barnes *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 44-52 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

The Satellite Servicer System Flight Demonstration (SSSFD) program is a series of Shuttle flights designed to verify major on-orbit satellite servicing capabilities, such as rendezvous and docking of free flyers, Orbital Replacement Unit (ORU) exchange, and fluid transfer. A major part of this system is the manipulator system that will perform the ORU exchange. The manipulator must possess adequate toolplate dexterity to maneuver a variety of EVA-type tools into position to interface with ORU fasteners, connectors, latches, and handles on the satellite, and to move workpieces and ORUs through 6 degree of freedom (dof) space from the Target Vehicle (TV) to the Support Module (SM) and back. Two cost efficient tools were combined to perform a study of robot manipulator design parameters. These tools are graphical computer simulations and Taguchi Design of Experiment methods. Using a graphics platform, an off-the-shelf robot simulation software package, and an experiment designed with Taguchi's approach, the sensitivities of various manipulator kinematic design parameters to performance characteristics are determined with minimal cost. Author

**N91-20648*#** Wisconsin Univ., Madison. Center for Space Automation and Robotics.
**IMPACT OF INERTIA, FRICTION, AND BACKLASH UPON FORCE CONTROL IN TELEMANIPULATION** **c37**
Neil A. Duffie, John J. Zik, Steven F. Wiker, and Karen L. Gale *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR

90) Jan. 1991 p 53-58 (For primary document see N91-20641 12-59)
(Grant NAGw-975)
Avail: NTIS HC/MF A21 CSCL 13I

The mechanical behavior of master controllers of telemanipulators has been a concern of both designers and implementors of telerobotic systems. In general, the literature recommends that telemanipulator systems be constructed that minimize inertia, friction, and backlash in an effort to improve telemanipulative performance. For the most part, these recommendations are founded upon theoretical analysis or simply intuition. Although these recommendations are not challenged on their merit, the material results are measured of building and fielding telemanipulators that possess less than ideal mechanical behaviors. Experiments are described in which forces in a mechanical system with human input are evaluated as a function of mechanical characteristics such as inertia, friction, and backlash. Results indicate that the ability of the human to maintain gripping forces was relatively unaffected by dynamic characteristics in the range studied, suggesting that telemanipulator design in this range should be based on task level force control requirements rather than human factors. Author

**N91-20649*#** Michigan Univ., Ann Arbor. Artificial Intelligence Lab.
**ADAPTIVE CONTROL OF SPACE BASED ROBOT MANIPULATORS** **c37**
Michael W. Walker and Liang-Boon Wee *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 59-66 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

For space based robots in which the base is free to move, motion planning and control is complicated by uncertainties in the inertial properties of the manipulator and its load. A new adaptive control method is presented for space based robots which achieves globally stable trajectory tracking in the presence of uncertainties in the inertial parameters of the system. A partition is made of the fifteen degree of freedom system dynamics into two parts: a nine degree of freedom invertible portion and a six degree of freedom noninvertible portion. The controller is then designed to achieve trajectory tracking of the invertible portion of the system. This portion consist of the manipulator joint positions and the orientation of the base. The motion of the noninvertible portion is bounded, but unpredictable. This portion consist of the position of the robot's base and the position of the reaction wheel. Author

**N91-20650*#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. Dept. of Electrical and Computer Engineering.
**THE AFIT GROSS MOTION CONTROL PROJECT** **c37**
M. B. Leahy, Jr. *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 67-73 Sponsored in part by AMRL, Wright-Patterson AFB, OH (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

The objective of the Gross Motion Control project is to study alternative control approaches that will provide payload invariant high speed trajectory tracking for nonrepetitive motions in free space. The research has concentrated on modifications to the model-based control structure. Development and evaluation is being actively pursued of both adaptive primary (inner loop) and robust secondary (output loop) controllers. In-house developments are compared and contrasted to the techniques proposed by other researchers. The case study for the evaluation is the first three links of a PUMA-560. Incorporating the principals of multiple model adaptive estimation, artificial neural networks, and Lyapunov theory into the model based paradigm has shown the potential for enhanced tracking. Secondary controllers based on Quantitative Feedback Theory, or augmented with auxiliary inputs, significantly improve the robustness to payload variations and unmodeled drive system dynamics. An overview is presented of the different concepts under investigation and a sample is provided of the latest experimental results. Author

**N91-20651*#** National Aeronautics and Space Administration, Washington, DC.
**NASA PLANETARY ROVER PROGRAM** **c37**
David Lavery and Roger J. Bedard, Jr. (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 78-83 Previously announced in IAA as A91-13756 (For primary document see N91-20641 12-59)
(Contract NAS7-918; NAGw-1175)
Avail: NTIS HC/MF A21 CSCL 13I

The NASA Planetary Rover Project was initiated in 1989. The emphasis of the work to date has been on development of autonomous navigation technology within the context of a high mobility wheeled vehicle at the JPL and an innovative legged locomotion concept at Carnegie Mellon University. The status and accomplishments of these two efforts are discussed. First, however, background information is given on the three rover types required for the Space Exploration Initiative (SEI) whose objective is a manned mission to Mars. Author

**N91-20652*#** California Cybernetics Corp., Sunland.
**AN ARCHITECTURAL APPROACH TO CREATE SELF ORGANIZING CONTROL SYSTEMS FOR PRACTICAL AUTONOMOUS ROBOTS** **c37**
Helen Greiner *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 84-90 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

For practical industrial applications, the development of trainable robots is an important and immediate objective. Therefore, the developing of flexible intelligence directly applicable to training is emphasized. It is generally agreed upon by the AI community that the fusion of expert systems, neural networks, and conventionally programmed modules (e.g., a trajectory generator) is promising in the quest for autonomous robotic intelligence. Autonomous robot development is hindered by integration and architectural problems. Some obstacles towards the construction of more general robot control systems are as follows: (1) Growth problem; (2) Software generation; (3) Interaction with environment; (4) Reliability; and (5) Resource limitation. Neural networks can be successfully applied to some of these problems. However, current implementations of neural networks are hampered by the resource limitation problem and must be trained extensively to produce computationally accurate output. A generalization of conventional neural nets is proposed, and an architecture is offered in an attempt to address the above problems. Author

**N91-20653*#** Carnegie-Mellon Univ., Pittsburgh, PA. Robotics Inst.
**A SIMPLE 5-DOF WALKING ROBOT FOR SPACE STATION APPLICATION** **c37**
H. Benjamin Brown, Jr., Mark B. Friedman, and Takeo Kanade *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 91-95 Sponsored in part by Shimizu Corp., Japan (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

Robots on the NASA space station have a potential range of applications from assisting astronauts during EVA (extravehicular activity), to replacing astronauts in the performance of simple, dangerous, and tedious tasks; and to performing routine tasks such as inspections of structures and utilities. To provide a vehicle for demonstrating the pertinent technologies, a simple robot is being developed for locomotion and basic manipulation on the proposed space station. In addition to the robot, an experimental testbed was developed, including a 1/3 scale (1.67 meter modules) truss and a gravity compensation system to simulate a zero-gravity environment. The robot comprises two flexible links connected by

a rotary joint, with a 2 degree of freedom wrist joints and grippers at each end. The grippers screw into threaded holes in the nodes of the space station truss, and enable it to walk by alternately shifting the base of support from one foot (gripper) to the other. Present efforts are focused on mechanical design, application of sensors, and development of control algorithms for lightweight, flexible structures. Long-range research will emphasize development of human interfaces to permit a range of control modes from teleoperated to semiautonomous, and coordination of robot/astronaut and multiple-robot teams. Author

**N91-20654*#** Carnegie-Mellon Univ., Pittsburgh, PA. School of Computer Science.

**PERCEPTION, PLANNING, AND CONTROL FOR WALKING ON RUGGED TERRAIN** **c37**

Reid Simmons and Eric Krotkov *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 96-102 (For primary document see N91-20641 12-59)

(Grant NAGw-1175)

Avail: NTIS HC/MF A21 CSCL 13I

The CMU Planetary Rover project is developing a six-legged walking robot capable of autonomously navigating, exploring, and acquiring samples in rugged, unknown environments. To gain experience with the problems involved in walking on rugged terrain, a full-scale prototype leg was built and mounted on a carriage that rolls along overhead rails. Issues addressed in developing the software system to autonomously walk the leg through rugged terrain are described. In particular, the insights gained into perceiving and modeling rugged terrain, controlling the legged mechanism, interacting with the ground, choosing safe yet effective footfalls, and planning efficient leg moves through space are described. Author

**N91-20655*#** Wisconsin Univ., Madison. Center for Space Automation and Robotics.

**COMPARISON OF FORCE AND TACTILE FEEDBACK FOR GRASP FORCE CONTROL IN TELEMANIPULATION** **c37**

Steven F. Wiker, Neil A. Duffie, Thomas Y. Yen, and Karen L. Gale *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 104-112 (For primary document see N91-20641 12-59)

(Grant NAGw-975)

Avail: NTIS HC/MF A21 CSCL 13I

The comparative efficacy of using direct force feedback or a simple vibrotactile display to convey changes in the intensity of remote grasp force relayed from a robotic end effector is examined. The findings show that a simple vibrotactile cue, in the absence of direct force feedback, is effective in signaling abrupt changes in remote grasp force regardless of magnitude, and when changes in force are not too slow or protracted in nature (i.e., ramp time less than 2 s). In cases where the operator must dynamically tract and respond to slow but large variations in grasp force, the comparatively crude vibrotactile display would prove helpful; but would not be as effective as that of a direct contact force display. Immediate applications and utility of current generation and near-term prototype tactile displays are discussed. Author

**N91-20656*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

**AUTONOMOUS PROXIMITY OPERATIONS USING MACHINE VISION FOR TRAJECTORY CONTROL AND POSE ESTIMATION** **c37**

Timothy F. Cleghorn and Stanley R. Sternberg (Machine Vision International Ltd., Ann Arbor, MI.) *In its* Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 113-119 (For primary document see N91-20641 12-59)

(Contract NAS9-17814)

Avail: NTIS HC/MF A21 CSCL 13I

A machine vision algorithm was developed which permits guidance control to be maintained during autonomous proximity operations. At present this algorithm exists as a simulation, running upon an 80386 based personal computer, using a ModelMATE CAD package to render the target vehicle. However, the algorithm is sufficiently simple, so that following off-line training on a known target vehicle, it should run in real time with existing vision hardware. The basis of the algorithm is a sequence of single camera images of the target vehicle, upon which radial transforms were performed. Selected points of the resulting radial signatures are fed through a decision tree, to determine whether the signature matches that of the known reference signatures for a particular view of the target. Based upon recognized scenes, the position of the maneuvering vehicle with respect to the target vehicles can be calculated, and adjustments made in the former's trajectory. In addition, the pose and spin rates of the target satellite can be estimated using this method. Author

**N91-20657*#** Lockheed Engineering and Sciences Co., Houston, TX. Dept. of Simulation Development.

**BERTHING SIMULATOR FOR SPACE STATION AND ORBITER** **c14**

Sam Veerasamy *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 120-125 (For primary document see N91-20641 12-59)

Avail: NTIS HC/MF A21 CSCL 13I

The development of a real-time man-in-the-loop berthing simulator is in progress at NASA Lyndon B. Johnson Space Center (JSC) to conduct a parametric study and to measure forces during contact conditions of the actual docking mechanisms for the Space Station Freedom and the orbiter. In berthing, the docking ports of the Space Station and the orbiter are brought together using the orbiter robotic arm to control the relative motion of the vehicles. The berthing simulator consists of a dynamics docking test system (DDTS), computer system, simulator software, and workstations. In the DDTS, the Space Station, and the orbiter docking mechanisms are mounted on a six-degree-of-freedom (6 DOF) table and a fixed platform above the table. Six load cells are used on the fixed platform to measure forces during contact conditions of the docking mechanisms. Two Encore Concept 32/9780 computers are used to simulate the orbiter robotic arm and to operate the berthing simulator. A systematic procedure for a real-time dynamic initialization is being developed to synchronize the Space Station docking port trajectory with the 6 DOF table movement. The berthing test can be conducted manually or automatically and can be extended for any two orbiting vehicles using a simulated robotic arm. The real-time operation of the berthing simulator is briefly described. Author

**N91-20658*#** Spectra Research Systems, Inc., Huntsville, AL.

**EVALUATION OF TELEROBOTIC SYSTEMS USING AN INSTRUMENTED TASK BOARD** **c37**

John D. Carroll, Paul A. Gierow, and Thomas C. Bryan *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 126-131 (For primary document see N91-20641 12-59)

(Contract NAS8-36307)

Avail: NTIS HC/MF A21 CSCL 13I

An instrumented task board was developed at NASA Marshall Space Flight Center (MSFC). An overview of the task board design, and current development status is presented. The task board was originally developed to evaluate operator performance using the Protoflight Manipulator Arm (PFMA) at MSFC. The task board evaluates tasks for Orbital Replacement Unit (ORU), fluid connect and transfers, electrical connect/disconnect, bolt running, and other basic tasks. The instrumented task board measures the 3-D forces and torques placed on the board, determines the robot arm's 3-D position relative to the task board using IR optics, and provides the information in real-time. The PFMA joint input signals can also be measured from a breakout box to evaluate the sensitivity or response of the arm operation to control commands. The data processing system provides the capability for post processing of time-history graphics and plots of the PFMA positions, the

operator's actions, and the PFMA servo reactions in addition to real-time force/torque data presentation. The instrumented task board's most promising use is developing benchmarks for NASA centers for comparison and evaluation of telerobotic performance.
Author

**N91-20659*#** Spar Aerospace Ltd., Weston (Ontario). Space Operations Div.
**OPERATIONS WITH THE SPECIAL PURPOSE DEXTROUS MANIPULATOR ON SPACE STATION FREEDOM** **c37**
B. Cox, D. Brown, and M. Hiltz *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 134-142 Sponsored in part by Canadian Space Agency, Houston, TX (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

SPAR Canada is actively participating in the Space Station Freedom Program by contributing the Mobile Servicing System (MSS) which will be involved in assembly, maintenance and servicing of both the Space Station and the MSS itself. Part of the MSS is the Special Purpose Dextrous Manipulator (SPDM), a two armed dextrous robot with advanced vision and manipulative capabilities. In addition to Space Station and payload servicing activities the SPDM will be designed to perform self maintenance on the MSS itself. The majority of Space Station equipment will be on orbit for the anticipated 30 year lifespan and the maintenance philosophy will be to repair by the exchange of Orbit Replacement Units or ORUs. The present concept, configuration, and operation of the SPDM and the detailed simulations associated with the maintenance of part of the MSS are described. The Design Reference Mission is the replacement of a Joint Drive Module on the Canadian large payload manipulator, the Space Station Remote Manipulator System. Other Design Reference Missions that were investigated are briefly described, and future operations activity to support the definition of SPDM requirements are discussed.
Author

**N91-20660*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**A SPACE SERVICING TELEROBOTICS TECHNOLOGY DEMONSTRATION** **c37**
Edwin P. Kan and Neville I. Marzwell *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 143-150 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

Supervised telerobotic controls provide the key to successful remote servicing, as demonstrated in the telerobot testbed of the jet propulsion laboratory. Such advanced techniques and systems are specially applicable to ground-remote operations for servicing tasks, which are to be performed remotely in space and to be operated under human supervision from the ground. Laboratory demonstrations have successfully proven the utility of such techniques and systems. Instrumental to the success of supervised robotic operations are the techniques called object designate and relative target. In addition, a technique called universal camera calibration was also applied in the telerobot testbed. Generalized compliant control techniques were used in the robotic removal and insertion operations. These techniques were proven successful in task situations where preprogrammed automation cannot be adequately exercised due to errors, changes, or omission in the worksite data base.
Author

**N91-20661*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**THE DEVELOPMENT TEST FLIGHT OF THE FLIGHT TELEROBOTIC SERVICER** **c16**
J. Andary, P. Spidaliere, and R. Sosnay (Martin Marietta Corp., Denver, CO.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 151-158 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 22B

The Development Test Flight (DTF-1) is the first of two shuttle flights to test operations of the Flight Telerobotic Servicer (FTS) in space and to demonstrate its capabilities in performing tasks for Space Station Freedom. The DTF-1 system, which Martin Marietta Astronautics Group is designing and building for the Goddard Space Flight Center, will be flown in December, 1991, as an attached payload on the shuttle. The design of the DTF-1 system, the tests to be performed, and the data to be gathered are discussed.
Author

**N91-20662*#** New Mexico Univ., Albuquerque. Dept. of Mechanical Engineering.
**DEPLOYABLE ROBOTIC WOVEN WIRE STRUCTURES AND JOINTS FOR SPACE APPLICATIONS** **c37**
Mo Shahinpoor and Bradford Smith (Woven Wire Corp., Santa Fe, NM.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 159-166 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 13I

Deployable robotic structures are basically expandable and contractable structures that may be transported or launched to space in a compact form. These structures may then be intelligently deployed by suitable actuators. The deployment may also be done by means of either airbag or spring-loaded typed mechanisms. The actuators may be pneumatic, hydraulic, ball-screw type, or electromagnetic. The means to trigger actuation may be on-board EPROMS, programmable logic controllers (PLCs) that trigger actuation based on some input caused by the placement of the structure in the space environment. The actuation may also be performed remotely by suitable remote triggering devices. Several deployable woven wire structures are examined. These woven wire structures possess a unique form of joint, the woven wire joint, which is capable of moving and changing its position and orientation with respect to the structure itself. Due to the highly dynamic and articulate nature of these joints the 3-D structures built using them are uniquely and highly expandable, deployable, and dynamic. The 3-D structure naturally gives rise to a new generation of deployable three-dimensional spatial structures.
Author

**N91-20663*#** Lockheed Engineering and Sciences Co., Houston, TX.
**INVESTIGATION OF VARYING GRAY SCALE LEVELS FOR REMOTE MANIPULATION** **c74**
John M. Bierschwale, Mark A. Stuart, and Carlos E. Sampaio *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 172-178 (For primary document see N91-20641 12-59)
(Contract NAS9-17900)
Avail: NTIS HC/MF A21 CSCL 20F

A study was conducted to investigate the effects of variant monitor gray scale levels and workplace illumination levels on operators' ability to discriminate between different colors on a monochrome monitor. It was determined that 8-gray scale viewing resulted in significantly worse discrimination performance compared to 16- and 32-gray scale viewing and that there was only a negligible difference found between 16 and 32 shades of gray. Therefore, it is recommended that monitors used while performing remote manipulation tasks have 16 or above shades of gray since this evaluation has found levels lower than this to be unacceptable for color discrimination task. There was no significant performance difference found between a high and a low workplace illumination condition. Further analysis was conducted to determine which specific combinations of colors can be used in conjunction with each other to ensure errorfree color coding/brightness discrimination performance while viewing a monochrome monitor. It was found that 92 three-color combination and 9 four-color combinations could be used with 100 percent accuracy. The results can help to determine which gray scale levels should be provided on monochrome monitors as well as which colors to use to ensure

the maximal performance of remotely-viewed color discrimination/coding tasks. Author

**N91-20664*#** Lockheed Engineering and Sciences Co., Houston, TX.

**SPACE STATION FREEDOM COUPLING TASKS: AN EVALUATION OF THEIR SPACE OPERATIONAL COMPATIBILITY** **c18**

Carlos E. Sampaio, John M. Bierschwale, Terence F. Fleming, and Mark A. Stuart *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 179-183 (For primary document see N91-20641 12-59)

(Contract NAS9-17900)

Avail: NTIS HC/MF A21 CSCL 22B

The development of the Space Station Freedom tasks that are compatible with both telerobotic as well as extravehicular activity is a necessary redundancy in order to insure successful day to day operation. One task to be routinely performed aboard Freedom will be the changeout of various quick disconnect fluid connectors. In an attempt to resolve these potentially contradictory issues of compatibility, mock-ups of couplings suitable to both extravehicular as well as telerobotic activity were designed and built. An evaluation performed at the Remote Operator Interaction Laboratory at NASA's Johnson Space Center is discussed, which assessed the prototype couplings as well as three standard coupling designs. Data collected during manual and telerobotic manipulation of the couplings indicated that the custom coupling was in fact shown to be faster to operate and generally preferred over the standard coupling designs. Author

**N91-20665*#** National Aeronautics and Space Administration, Washington, DC.

**GROUND CONTROLLED ROBOTIC ASSEMBLY OPERATIONS FOR SPACE STATION FREEDOM** **c37**

Joseph C. Parrish *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 184-191 (For primary document see N91-20641 12-59)

Avail: NTIS HC/MF A21 CSCL 13I

A number of dextrous robotic systems and associated positioning and transportation devices are available on Space Station Freedom (SSF) to perform assembly tasks that would otherwise need to be performed by extravehicular activity (EVA) crewmembers. The currently planned operating mode for these robotic systems during the assembly phase is teleoperation by intravehicular activity (IVA) crewmembers. While this operating mode is less hazardous and expensive than manned EVA operations, and has insignificant control loop time delays, the amount of IVA time available to support telerobotic operations is much less than the anticipated requirements. Some alternative is needed to allow the robotic systems to perform useful tasks without exhausting the available IVA resources; ground control is one such alternative. The issues associated with ground control of SSF robotic systems to alleviate onboard crew time availability constraints are investigated. Key technical issues include the effect of communication time delays, the need for safe, reliable execution of remote operations, and required modifications to the SSF ground and flight system architecture. Time delay compensation techniques such as predictive displays and world model-based force reflection are addressed and collision detection and avoidance strategies to ensure the safety of the on-orbit crew, Orbiter, and SSF are described. Although more time consuming and difficult than IVA controlled teleoperations or manned EVA, ground controlled telerobotic operations offer significant benefits during the SSF assembly phase, and should be considered in assembly planning activities. Author

**N91-20666*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

**A COLLISION DETECTION ALGORITHM FOR TELEROBOTIC ARMS** **c63**

Doan Minh Tran (ST Systems Corp., Lanham, MD.) and Maureen OBrien Bartholomew *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 194-200 (For primary document see N91-20641 12-59)

Avail: NTIS HC/MF A21 CSCL 09B

The telerobotic manipulator's collision detection algorithm is described. Its applied structural model of the world environment and template representation of objects is evaluated. Functional issues that are required for the manipulator to operate in a more complex and realistic environment are discussed. Author

**N91-20667*#** Rice Univ., Houston, TX. Dept. of Electrical and Computer Engineering.

**EXACT AND EXPLICIT OPTIMAL SOLUTIONS FOR TRAJECTORY PLANNING AND CONTROL OF SINGLE-LINK FLEXIBLE-JOINT MANIPULATORS** **c63**

Guanrong Chen *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 201-206 (For primary document see N91-20641 12-59)

(Contract N00014-88-K-0127)

Avail: NTIS HC/MF A21 CSCL 09B

An optimal trajectory planning problem for a single-link, flexible joint manipulator is studied. A global feedback-linearization is first applied to formulate the nonlinear inequality-constrained optimization problem in a suitable way. Then, an exact and explicit structural formula for the optimal solution of the problem is derived and the solution is shown to be unique. It turns out that the optimal trajectory planning and control can be done off-line, so that the proposed method is applicable to both theoretical analysis and real time tele-robotics control engineering. Author

**N91-20668*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

**ISSUES ASSOCIATED WITH ESTABLISHING CONTROL ZONES FOR INTERNATIONAL SPACE OPERATIONS** **c84**

Blair A. Nader and Kumar Krishen *In its* Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 207-225 (For primary document see N91-20641 12-59)

Avail: NTIS HC/MF A21 CSCL 05D

Cooperative missions in Earth orbit can be facilitated by developing a strategy to regulate the manner in which vehicles interact in orbit. One means of implementing such a strategy is to utilize a control zones technique that assigns different types of orbital operations to specific regions of space surrounding a vehicle. Considered here are issues associated with developing a control zones technique to regulate the interactions of spacecraft in proximity to a manned vehicle. Technical and planning issues, flight hardware and software issues, mission management parameter, and other constraints are discussed. Also covered are manned and unmanned vehicle operations, and manual versus automated flight control. A review of the strategies utilized by the Apollo Soyuz Test Project and the Space Station Freedom Program is also presented. Author

**N91-20669*#** Carnegie-Mellon Univ., Pittsburgh, PA. Robotics Inst.

**A PERCEPTION AND MANIPULATION SYSTEM FOR COLLECTING ROCK SAMPLES** **c91**

T. Choi, H. Delingette, M. DeLuise, Y. Hsin, M. Hebert, and Katsushi Ikeuchi *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 226-233 (For primary document see N91-20641 12-59)

(Grant NAGw-1175)

Avail: NTIS HC/MF A21 CSCL 03B

An important part of a planetary exploration mission is to collect and analyze surface samples. As part of the Carnegie Mellon University Ambler Project, researchers are investigating techniques for collecting samples using a robot arm and a range sensor. The aim of this work is to make the sample collection operation fully autonomous. Described here are the components of the

experimental system, including a perception module that extracts objects of interest from range images and produces models of their shapes, and a manipulation module that enables the system to pick up the objects identified by the perception module. The system was tested on a small testbed using natural terrain.
Author

**N91-20670*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**ADVANCED AUTOMATION IN SPACE SHUTTLE MISSION CONTROL** **c66**
Troy A. Heindel, Arthur N. Rasmussen, and Robert Z. McFarland (Unisys Corp., Houston, TX.) *In its* Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 236-243 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 12B

The Real Time Data System (RTDS) Project was undertaken in 1987 to introduce new concepts and technologies for advanced automation into the Mission Control Center environment at NASA's Johnson Space Center. The project's emphasis is on producing advanced near-operational prototype systems that are developed using a rapid, interactive method and are used by flight controllers during actual Shuttle missions. In most cases the prototype applications have been of such quality and utility that they have been converted to production status. A key ingredient has been an integrated team of software engineers and flight controllers working together to quickly evolve the demonstration systems.
Author

**N91-20671*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**SHARP: AUTOMATED MONITORING OF SPACECRAFT HEALTH AND STATUS** **c12**
David J. Atkinson, Mark L. James, and R. Gaius Martin *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 244-258 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 22A

Briefly discussed here are the spacecraft and ground systems monitoring process at the Jet Propulsion Laboratory (JPL). Some of the difficulties associated with the existing technology used in mission operations are highlighted. A new automated system based on artificial intelligence technology is described which seeks to overcome many of these limitations. The system, called the Spacecraft Health Automated Reasoning Prototype (SHARP), is designed to automate health and status analysis for multi-mission spacecraft and ground data systems operations. The system has proved to be effective for detecting and analyzing potential spacecraft and ground systems problems by performing real-time analysis of spacecraft and ground data systems engineering telemetry. Telecommunications link analysis of the Voyager 2 spacecraft was the initial focus for evaluation of the system in real-time operations during the Voyager spacecraft encounter with Neptune in August 1989.
Author

**N91-20672*#** Ford Aerospace Corp., Sunnyvale, CA. Artificial Intelligence Group.
**CHALLENGES IN BUILDING INTELLIGENT SYSTEMS FOR SPACE MISSION OPERATIONS** **c63**
Wayne Hartman *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 259-263 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

The purpose here is to provide a top-level look at the stewardship functions performed in space operations, and to identify the major issues and challenges that must be addressed to build intelligent systems that can realistically support operations functions. The focus is on decision support activities involving monitoring, state assessment, goal generation, plan generation, and plan execution. The bottom line is that problem solving in the space operations domain is a very complex process. A variety of knowledge constructs, representations, and reasoning processes are necessary to support effective human problem solving. Emulating these kinds of capabilities in intelligent systems offers major technical challenges that the artificial intelligence community is only beginning to address.
Author

**N91-20673*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**USER INTERFACE ISSUES IN SUPPORTING HUMAN-COMPUTER INTEGRATED SCHEDULING** **c66**
Lynne P. Cooper and Eric W. Biefeld *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 268-274 Sponsored in part by DoD (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 12B

Explored here is the user interface problems encountered with the Operations Missions Planner (OMP) project at the Jet Propulsion Laboratory (JPL). OMP uses a unique iterative approach to planning that places additional requirements on the user interface, particularly to support system development and maintenance. These requirements are necessary to support the concepts of heuristically controlled search, in-progress assessment, and iterative refinement of the schedule. The techniques used to address the OMP interface needs are given.
Author

**N91-20674*#** Boeing Computer Services Co., Huntsville, AL. Artificial Intelligence Center.
**ARCHITECTURE FOR SPACECRAFT OPERATIONS PLANNING** **c66**
William S. Davis *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 275-278 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 12B

A system which generates plans for the dynamic environment of space operations is discussed. This system synthesizes plans by combining known operations under a set of physical, functional, and temperal constraints from various plan entities, which are modeled independently but combine in a flexible manner to suit dynamic planning needs. This independence allows the generation of a single plan source which can be compiled and applied to a variety of agents. The architecture blends elements of temperal logic, nonlinear planning, and object oriented constraint modeling to achieve its flexibility. This system was applied to the domain of the Intravehicular Activity (IVA) maintenance and repair aboard Space Station Freedom testbed.
Author

**N91-20675*#** Mitre Corp., Bedford, MA.
**THE RANGE SCHEDULING AID** **c81**
Eliezer M. Halbfinger and Barry D. Smith *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 280-284 Sponsored in part by ESD, Hanscom AFB, MA (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 05A

The Air Force Space Command schedules telemetry, tracking and control activities across the Air Force Satellite Control network. The Range Scheduling Aid (RSA) is a rapid prototype combining a user-friendly, portable, graphical interface with a sophisticated object-oriented database. The RSA has been a rapid prototyping effort whose purpose is to elucidate and define suitable technology for enhancing the performance of the range schedulers. Designing a system to assist schedulers in their task and using their current techniques as well as enhancements enabled by an electronic environment, has created a continuously developing model that will serve as a standard for future range scheduling systems. The RSA system is easy to use, easily ported between platforms, fast, and provides a set of tools for the scheduler that substantially increases his productivity.
Author

**N91-20676*#** IBM Federal Systems Div., Colorado Springs, CO.
**REQUEST GENERATION 2 MISSION PLANNING AND SCHEDULING** **c81**
Darlene D. Greenhut *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 285-289 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 05A

Request Generation II (ReGe II) is a PC-based prototype knowledge based system intented to assist USAF personnel in planning and scheduling satellite operations for their Mission Control Complexes (MCC). It aids MCC personnel in producing weekly Program Action Plans (PAPs) for each of the satellite vehicles an MCC is responsible for monitoring and maintaining. The PAPs are input to the Resource Control Complex (RCC) which schedules all satellite support requests for usage of the network. Author

**N91-20677*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**THE AMES-LOCKHEED ORBITER PROCESSING SCHEDULING SYSTEM** **c81**
Monte Zweben and Robert Gargan (Lockheed Missiles and Space Co., Palo Alto, CA.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 290-295 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 05A

A general purpose scheduling system and its application to Space Shuttle Orbiter Processing at the Kennedy Space Center (KSC) are described. Orbiter processing entails all the inspection, testing, repair, and maintenance necessary to prepare the Shuttle for launch and takes place within the Orbiter Processing Facility (OPF) at KSC, the Vehicle Assembly Building (VAB), and on the launch pad. The problems are extremely combinatoric in that there are thousands of tasks, resources, and other temporal considerations that must be coordinated. Researchers are building a scheduling tool that they hope will be an integral part of automating the planning and scheduling process at KSC. The scheduling engine is domain independent and is also being applied to Space Shuttle cargo processing problems as well as wind tunnel scheduling problems. Author

**N91-20678*#** Decision-Science Applications, Inc., Arlington, VA.
**AN INTELLIGENT VALUE-DRIVEN SCHEDULING SYSTEM FOR SPACE STATION FREEDOM WITH SPECIAL EMPHASIS ON THE ELECTRIC POWER SYSTEM** **c20**
Joseph C. Krupp *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 296-300 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 10B

The Electric Power Control System (EPCS) created by Decision-Science Applications, Inc. (DSA) for the Lewis Research Center is discussed. This system makes decisions on what to schedule and when to schedule it, including making choices among various options or ways of performing a task. The system is goal-directed and seeks to shape resource usage in an optimal manner using a value-driven approach. Discussed here are considerations governing what makes a good schedule, how to design a value function to find the best schedule, and how to design the algorithm that finds the schedule that maximizes this value function. Results are shown which demonstrate the usefulness of the techniques employed. Author

**N91-20679*#** General Dynamics Corp., San Diego, CA. Space Systems Div.
**EXPERT SYSTEM DECISION SUPPORT FOR LOW-COST LAUNCH VEHICLE OPERATIONS** **c15**
G. P. Szatkowski and Barry E. Levin *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 304-316 Sponsored in part by AFSD (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 22B

Progress in assessing the feasibility, benefits, and risks associated with AI expert systems applied to low cost expendable launch vehicle systems is described. Part one identified potential application areas in vehicle operations and on-board functions, assessed measures of cost benefit, and identified key technologies to aid in the implementation of decision support systems in this environment. Part two of the program began the development of prototypes to demonstrate real-time vehicle checkout with controller and diagnostic/analysis intelligent systems and to gather true measures of cost savings vs. conventional software, verification and validation requirements, and maintainability improvement. The main objective of the expert advanced development projects was to provide a robust intelligent system for control/analysis that must be performed within a specified real-time window in order to meet the demands of the given application. The efforts to develop the two prototypes are described. Prime emphasis was on a controller expert system to show real-time performance in a cryogenic propellant loading application and safety validation implementation of this system experimentally, using commercial-off-the-shelf software tools and object oriented programming techniques. This smart ground support equipment prototype is based in C with imbedded expert system rules written in the CLIPS protocol. The relational database, ORACLE, provides non-real-time data support. The second demonstration develops the vehicle/ground intelligent automation concept, from phase one, to show cooperation between multiple expert systems. This automated test conductor (ATC) prototype utilizes a knowledge-bus approach for intelligent information processing by use of virtual sensors and blackboards to solve complex problems. It incorporates distributed processing of real-time data and object-oriented techniques for command, configuration control, and auto-code generation. Author

**N91-20680*#** Lockheed Space Operations Co., Cocoa Beach, FL.
**KSC'S WORK FLOW ASSISTANT** **c81**
John Wilkinson and Earl Johnson *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 317-322 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 05A

The work flow assistant (WFA) is an advanced technology project under the shuttle processing data management system (SPDMS) at Kennedy Space Center (KSC). It will be utilized for short range scheduling, controlling work flow on the floor, and providing near real-time status for all major space transportation systems (STS) work centers at KSC. It will increase personnel and STS safety and improve productivity through deeper active scheduling that includes tracking and correlation of STS and ground support equipment (GSE) configuration and work. It will also provide greater accessibility to this data. WFA defines a standards concept for scheduling data which permits both commercial off-the-shelf (COTS) scheduling tools and WFA developed applications to be reused. WFA will utilize industry standard languages and workstations to achieve a scalable, adaptable, and portable architecture which may be used at other sites. Author

**N91-20681*#** Symbiotics, Inc., Cambridge, MA.
**EXODUS: INTEGRATING INTELLIGENT SYSTEMS FOR LAUNCH OPERATIONS SUPPORT** **c15**
Richard M. Adler and Bruce H. Cottman *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 324-330 (For primary document see N91-20641 12-59)
(Contracts NAS10-11606; DAAB10-87-C-0053)
Avail: NTIS HC/MF A21 CSCL 22B

Kennedy Space Center (KSC) is developing knowledge-based systems to automate critical operations functions for the space shuttle fleet. Intelligent systems will monitor vehicle and ground support subsystems for anomalies, assist in isolating and managing faults, and plan and schedule shuttle operations activities. These

applications are being developed independently of one another, using different representation schemes, reasoning and control models, and hardware platforms. KSC has recently initiated the EXODUS project to integrate these stand alone applications into a unified, coordinated intelligent operations support system. EXODUS will be constructed using SOCIAL, a tool for developing distributed intelligent systems. EXODUS, SOCIAL, and initial prototyping efforts using SOCIAL to integrate and coordinate selected EXODUS applications are described. Author

**N91-20682*#** National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
**AN INTELLIGENT ADVISORY SYSTEM FOR PRE-LAUNCH PROCESSING** **c63**
Peter A. Engrand and Tami Mitchell *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 331-336 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

The shuttle system of interest in this paper is the shuttle's data processing system (DPS). The DPS is composed of the following: (1) general purpose computers (GPC); (2) a multifunction CRT display system (MCDS); (3) mass memory units (MMU); and (4) a multiplexer/demultiplexer (MDM) and related software. In order to ensure the correct functioning of shuttle systems, some level of automatic error detection has been incorporated into all shuttle systems. For the DPS, error detection equipment has been incorporated into all of its subsystems. The automated diagnostic system, (MCDS) diagnostic tool, that aids in a more efficient processing of the DPS is described. K.S.

**N91-20683*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**INTELLIGENT MONITORING AND DIAGNOSIS SYSTEMS FOR THE SPACE STATION FREEDOM ECLSS** **c54**
Brandon S. Dewberry and James R. Carnes (Boeing Co., Huntsville, AL.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 338-343 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 05H

Specific activities in NASA's environmental control and life support system (ECLSS) advanced automation project that is designed to minimize the crew and ground manpower needed for operations are discussed. Various analyses and the development of intelligent software for the initial and evolutionary Space Station Freedom (SSF) ECLSS are described. The following are also discussed: (1) intelligent monitoring and diagnostics applications under development for the ECLSS domain; (2) integration into the MSFC ECLSS hardware testbed; and (3) an evolutionary path from the baseline ECLSS automation to the more advanced ECLSS automation processes. Author

**N91-20684*#** Mitre Corp., Houston, TX.
**A FAILURE MANAGEMENT PROTOTYPE: DR/Rx** **c38**
David G. Hammen, Carolyn G. Baker, Christine M. Kelly, and Christopher A. Marsh *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 347-354 (For primary document see N91-20641 12-59)
(Contract NAS9-18057)
Avail: NTIS HC/MF A21 CSCL 14D

This failure management prototype performs failure diagnosis and recovery management of hierarchical, distributed systems. The prototype, which evolved from a series of previous prototypes following a spiral model for development, focuses on two functions: (1) the diagnostic reasoner (DR) performs integrated failure diagnosis in distributed systems; and (2) the recovery expert (Rx) develops plans to recover from the failure. Issues related to expert system prototype design and the previous history of this prototype are discussed. The architecture of the current prototype is described in terms of the knowledge representation and functionality of its components. Author

**N91-20685*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**AUGMENTATION OF THE SPACE STATION MODULE POWER MANAGEMENT AND DISTRIBUTION BREADBOARD** **c20**
Bryan Walls, David K. Hall, and Louis F. Lollar *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 355-359 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 10B

The space station module power management and distribution (SSM/PMAD) breadboard models power distribution and management, including scheduling, load prioritization, and a fault detection, identification, and recovery (FDIR) system within a Space Station Freedom habitation or laboratory module. This 120 VDC system is capable of distributing up to 30 kW of power among more than 25 loads. In addition to the power distribution hardware, the system includes computer control through a hierarchy of processes. The lowest level consists of fast, simple (from a computing standpoint) switchgear that is capable of quickly safing the system. At the next level are local load center processors, (LLP's) which execute load scheduling, perform redundant switching, and shed loads which use more than scheduled power. Above the LLP's are three cooperating artificial intelligence (AI) systems which manage load prioritizations, load scheduling, load shedding, and fault recovery and management. Recent upgrades to hardware and modifications to software at both the LLP and AI system levels promise a drastic increase in speed, a significant increase in functionality and reliability, and potential for further examination of advanced automation techniques. The background, SSM/PMAD, interface to the Lewis Research Center test bed, the large autonomous spacecraft electrical power system, and future plans are discussed. Author

**N91-20686*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**THE REAL-TIME CONTROL OF PLANETARY ROVERS THROUGH BEHAVIOR MODIFICATION** **c63**
David P. Miller *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 362-366 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

It is not yet clear of what type, and how much, intelligence is needed for a planetary rover to function semi-autonomously on a planetary surface. Current designs assume an advanced AI system that maintains a detailed map of its journeys and the surroundings, and that carefully calculates and tests every move in advance. To achieve these abilities, and because of the limitations of space-qualified electronics, the supporting rover is quite sizable, massing a large fraction of a ton, and requiring technology advances in everything from power to ground operations. An alternative approach is to use a behavior driven control scheme. Recent research has shown that many complex tasks may be achieved by programming a robot with a set of behaviors and activation or deactivating a subset of those behaviors as required by the specific situation in which the robot finds itself. Behavior control requires much less computation than is required by tradition AI planning techniques. The reduced computation requirements allows the entire rover to be scaled down as appropriate (only down-link communications and payload do not scale under these circumstances). The missions that can be handled by the real-time control and operation of a set of small, semi-autonomous, interacting, behavior-controlled planetary rovers are discussed. Author

**N91-20687*#** Thomson-CSF, Palo Alto, CA.
**REASONING ABOUT REAL-TIME SYSTEMS WITH TEMPORAL INTERVAL LOGIC CONSTRAINTS ON MULTI-STATE AUTOMATA** **c63**
Armen Gabrielian *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 368-374 (For primary

document see N91-20641 12-59)
(Contract N00014-89-C-0022)
Avail: NTIS HC/MF A21 CSCL 09B

Models of real-time systems using a single paradigm often turn out to be inadequate, whether the paradigm is based on states, rules, event sequences, or logic. A model-based approach to reasoning about real-time systems is presented in which a temporal interval logic called TIL is employed to define constraints on a new type of high level automata. The combination, called hierarchical multi-state (HMS) machines, can be used to model formally a real-time system, a dynamic set of requirements, the environment, heuristic knowledge about planning-related problem solving, and the computational states of the reasoning mechanism. In this framework, mathematical techniques were developed for: (1) proving the correctness of a representation; (2) planning of concurrent tasks to achieve goals; and (3) scheduling of plans to satisfy complex temporal constraints. HMS machines allow reasoning about a real-time system from a model of how truth arises instead of merely depending of what is true in a system.
Author

**N91-20688*#** Inference Corp., El Segundo, CA.
**A FRAMEWORK FOR BUILDING REAL-TIME EXPERT SYSTEMS** **c63**
S. Daniel Lee *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 375-382 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

The Space Station Freedom is an example of complex systems that require both traditional and artificial intelligence (AI) real-time methodologies. It was mandated that Ada should be used for all new software development projects. The station also requires distributed processing. Catastrophic failures on the station can cause the transmission system to malfunction for a long period of time, during which ground-based expert systems cannot provide any assistance to the crisis situation on the station. This is even more critical for other NASA projects that would have longer transmission delays (e.g., the lunar base, Mars missions, etc.). To address these issues, a distributed agent architecture (DAA) is proposed that can support a variety of paradigms based on both traditional real-time computing and AI. The proposed testbed for DAA is an autonomous power expert (APEX) which is a real-time monitoring and diagnosis expert system for the electrical power distribution system of the space station.
Author

**N91-20689*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**AUTONOMOUS POWER EXPERT SYSTEM ADVANCED DEVELOPMENT** **c20**
Todd M. Quinn (Sverdrup Technology, Inc., Brook Park, OH.) and Jerry L. Walters *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 383-390 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 10B

The autonomous power expert (APEX) system is being developed at Lewis Research Center to function as a fault diagnosis advisor for a space power distribution test bed. APEX is a rule-based system capable of detecting faults and isolating the probable causes. APEX also has a justification facility to provide natural language explanations about conclusions reached during fault isolation. To help maintain the health of the power distribution system, additional capabilities were added to APEX. These capabilities allow detection and isolation of incipient faults and enable the expert system to recommend actions/procedure to correct the suspected fault conditions. New capabilities for incipient fault detection consist of storage and analysis of historical data and new user interface displays. After the cause of a fault is determined, appropriate recommended actions are selected by rule-based inferencing which provides corrective/extended test procedures. Color graphics displays and improved mouse-selectable menus were also added to provide a friendlier user interface. A discussion of APEX in general and a more detailed description of the incipient detection, recommended actions, and user interface developments during the last year are presented.
Author

**N91-20690*#** Boeing Computer Services Co., Huntsville, AL. Artificial Intelligence Center.
**A KNOWLEDGE-BASED APPROACH TO CONFIGURATION LAYOUT, JUSTIFICATION, AND DOCUMENTATION** **c18**
F. G. Craig, D. E. Cutts, T. R. Fennel, C. M. Case, and J. R. Palmer (Boeing Aerospace and Electronics Co., Huntsville, AL.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 393-396 Previously announced in IAA as A90-27286 (For primary document see N91-20641 12-59)
Copyright Avail: NTIS HC/MF A21 CSCL 12A

The design, development, and implementation of a prototype expert system which could aid designers and system engineers in the placement of racks aboard modules on the Space Station Freedom are described. This type of problem is relevant to any program with multiple constraints and requirements demanding solutions which minimize usage of limited resources. This process is generally performed by a single, highly experienced engineer who integrates all the diverse mission requirements and limitations, and develops an overall technical solution which meets program and system requirements with minimal cost, weight, volume, power, etc. This system architect performs an intellectual integration process in which the underlying design rationale is often not fully documented. This is a situation which lends itself to an expert system solution for enhanced consistency, thoroughness, documentation, and change assessment capabilities.
Author

**N91-20691*#** Rockwell International Corp., Houston, TX.
**CAPTURING, USING, AND MANAGING QUALITY ASSURANCE KNOWLEDGE FOR SHUTTLE POST-MECO FLIGHT DESIGN** **c38**
H. L. Peters, L. R. Fussell, M. A. Goodwin, and Roger D. Schultz (Abacus Programming Corp., Van Nuys, CA.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 397-404 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 14D

Ascent initialization values used by the Shuttle's onboard computer for nominal and abort mission scenarios are verified by a six degrees of freedom computer simulation. The procedure that the Ascent Post Main Engine Cutoff (Post-MECO) group uses to perform quality assurance (QA) of the simulation is time consuming. Also, the QA data, checklists and associated rationale, though known by the group members, is not sufficiently documented, hindering transfer of knowledge and problem resolution. A new QA procedure which retains the current high level of integrity while reducing the time required to perform QA is needed to support the increasing Shuttle flight rate. Documenting the knowledge is also needed to increase its availability for training and problem resolution. To meet these needs, a knowledge capture process, embedded into the group activities, was initiated to verify the existing QA checks, define new ones, and document all rationale. The resulting checks were automated in a conventional software program to achieve the desired standardization, integrity, and time reduction. A prototype electronic knowledge base was developed with Macintosh's HyperCard to serve as a knowledge capture tool and data storage.
Author

**N91-20692*#** Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
**QUANTITATIVE KNOWLEDGE ACQUISITION FOR EXPERT SYSTEMS** **c63**
Brenda L. Belkin and Robert F. Stengel *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 405-413 (For primary document see N91-20641 12-59)
(Contract NGL-31-001-252; DAAG29-84-K-0048)
Avail: NTIS HC/MF A21 CSCL 09B

A common problem in the design of expert systems is the definition of rules from data obtained in system operation or simulation. While it is relatively easy to collect data and to log the comments of human operators engaged in experiments, generalizing such information to a set of rules has not previously been a direct task. A statistical method is presented for generating rule bases from numerical data, motivated by an example based on aircraft navigation with multiple sensors. The specific objective is to design an expert system that selects a satisfactory suite of measurements from a dissimilar, redundant set, given an arbitrary navigation geometry and possible sensor failures. The systematic development is described of a Navigation Sensor Management (NSM) Expert System from Kalman Filter convariance data. The method invokes two statistical techniques: Analysis of Variance (ANOVA) and the ID3 Algorithm. The ANOVA technique indicates whether variations of problem parameters give statistically different covariance results, and the ID3 algorithms identifies the relationships between the problem parameters using probabilistic knowledge extracted from a simulation example set. Both are detailed. Author

**N91-20693*#** Houston Univ., TX. Dept. of Psychology.
**THE DEVELOPMENT OF EXPERTISE USING AN INTELLIGENT COMPUTER-AIDED TRAINING SYSTEM c61**
Debra Steele Johnson *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 418-423 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

An initial examination was conducted of an Intelligent Tutoring System (ITS) developed for use in industry. The ITS, developed by NASA, simulated a satellite deployment task. More specifically, the PD (Payload Assist Module Deployment)/ICAT (Intelligent Computer Aided Training) System simulated a nominal Payload Assist Module (PAM) deployment. The development of expertise on this task was examined using three Flight Dynamics Officer (FDO) candidates who has no previous experience with this task. The results indicated that performance improved rapidly until Trial 5, followed by more gradual improvements through Trial 12. The performance dimensions measured included performance speed, actions completed, errors, help required, and display fields checked. Suggestions for further refining the software and for deciding when to expose trainees to more difficult task scenarios are discussed. Further, the results provide an initial demonstration of the effectiveness of the PD/ICAT system in training the nominal PAM deployment task and indicate the potential benefits of using ITS's for training other FDO tasks. Author

**N91-20694*#** Lockheed Space Operations Co., Cocoa Beach, FL.
**RULE-BASED SIMULATION MODELS c14**
Joseph L. Nieten and Kathleen M. Seraphine *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 424-428 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 14B

Procedural modeling systems, rule based modeling systems, and a method for converting a procedural model to a rule based model are described. Simulation models are used to represent real time engineering systems. A real time system can be represented by a set of equations or functions connected so that they perform in the same manner as the actual system. Most modeling system languages are based on FORTRAN or some other procedural language. Therefore, they must be enhanced with a reaction capability. Rule based systems are reactive by definition. Once the engineering system has been decomposed into a set of calculations using only basic algebraic unary operations, a knowledge network of calculations and functions can be constructed. The knowledge network required by a rule based system can be generated by a knowledge acquisition tool or a source level compiler. The compiler would take an existing model source file, a syntax template, and a symbol table and generate the knowledge network. Thus, existing procedural models can be translated and executed by a rule based system. Neural models can be provide the high capacity data manipulation required by the most complex real time models. Author

**N91-20695*#** Air Force Human Resources Lab., Brooks AFB, TX.
**ROSE GARDEN PROMISES OF INTELLIGENT TUTORING SYSTEMS: BLOSSOM OR THORN c63**
Valerie J. Shute *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 431-438 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

Intelligent tutoring systems (ITS) have been in existence for over a decade. However, few controlled evaluation studies have been conducted comparing the effectiveness of these systems to more traditional instruction methods. Two main promises of ITSs are examined: (1) Engender more effective and efficient learning in relation to traditional formats; and (2) Reduce the range of learning outcome measures where a majority of individuals are elevated to high performance levels. Bloom (1984) has referred to these as the two sigma problem; to achieve two standard deviation improvements with tutoring over traditional instruction methods. Four ITSs are discussed in relation to the two promises. These tutors have undergone systematic, controlled evaluations: (1) The LISP tutor (Anderson Farrell and Sauers, 1984); (2) Smithtown (Shute and Glaser, in press); (3) Sherlock (Lesgold, Lajoie, Bunzo and Eggan, 1990); and (4) The Pascal ITS (Bonar, Cunningham, Beatty and Well, 1988). Results show that these four tutors do accelerate learning with no degradation in final outcome. Suggestions for improvements to the design and evaluation of ITSs are discussed. Author

**N91-20696*#** New Mexico Univ., Albuquerque. Dept. of Civil Engineering.
**ASSESSING DAMPING UNCERTAINTY IN SPACE STRUCTURES WITH FUZZY SETS c18**
Timothy J. Ross and Timothy K. Hasselman (Engineering Mechanics Association, Inc., Torrance, CA.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 442-448 (For primary document see N91-20641 12-59)
(Contract NAS7-1020)
Avail: NTIS HC/MF A21 CSCL 22B

NASA has been interested in the development of methods for evaluating the predictive accuracy of structural dynamic models. This interest stems from the use of mathematical models in evaluating the structural integrity of all spacecraft prior to flight. Space structures are often too large and too weak to be tested fully assembled in a ground test lab. The predictive accuracy of a model depends on the nature and extent of its experimental verification. The further the test conditions depart from in-service conditions, the less accurate the model will be. Structural damping is known to be one source of uncertainty in models. The uncertainty in damping is explored in order to evaluate the accuracy of dynamic models. A simple mass-spring-dashpot system is used to illustrate a comparison among three methods for propagating uncertainty in structural dynamics models: the First Order Method, the Numerical Simulation Method, and the Fuzzy Set Method. The Fuzzy Set Method is shown to bound the range of possible responses and thus to provide a valuable limiting check on the First Order Method near resonant conditions. Fuzzy Methods are a relative inexpensive alternative to numerical simulation. Author

**N91-20697*#** Abacus Programming Corp., Van Nuys, CA.
**THE AI BUS ARCHITECTURE FOR DISTRIBUTED KNOWLEDGE-BASED SYSTEMS c63**
Roger D. Schultz and Iain Stobie *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 449-454 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

The AI Bus architecture is layered, distributed object oriented

framework developed to support the requirements of advanced technology programs for an order of magnitude improvement in software costs. The consequent need for highly autonomous computer systems, adaptable to new technology advances over a long lifespan, led to the design of an open architecture and toolbox for building large scale, robust, production quality systems. The AI Bus accommodates a mix of knowledge based and conventional components, running on heterogeneous, distributed real world and testbed environment. The concepts and design is described of the AI Bus architecture and its current implementation status as a Unix C++ library or reusable objects. Each high level semiautonomous agent process consists of a number of knowledge sources together with interagent communication mechanisms based on shared blackboards and message passing acquaintances. Standard interfaces and protocols are followed for combining and validating subsystems. Dynamic probes or demons provide an event driven means for providing active objects with shared access to resources, and each other, while not violating their security. Author

**N91-20698*#** Inference Corp., El Segundo, CA.
**ART-Ada: AN Ada-BASED EXPERT SYSTEM TOOL c61**
S. Daniel Lee and Bradley P. Allen *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 456-463 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

The Department of Defense mandate to standardize on Ada as the language for software systems development has resulted in increased interest in making expert systems technology readily available in Ada environments. NASA's Space Station Freedom is an example of the large Ada software development projects that will require expert systems in the 1990's. Another large scale application that can benefit from Ada based expert system tool technology is the Pilot's Associate (PA) expert system project for military combat aircraft. Automated Reasoning Tool (ART) Ada, an Ada Expert system tool is described. ART-Ada allow applications of a C-based expert system tool called ART-IM to be deployed in various Ada environments. ART-Ada is being used to implement several prototype expert systems for NASA's Space Station Freedom Program and the U.S. Air Force. Author

**N91-20699*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**ADVANCED CLIPS CAPABILITIES c61**
Gary Riley *In its* Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 464-468 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

The C Language Integrated Production System (CLIPS) is a forward chaining rule based language developed by NASA. CLIPS was designed specifically to provide high portability, low cost, and easy integration with external systems. The current release of CLIPS, version 4.3, is being used by over 2500 users throughout the public and private community. The primary addition to the next release of CLIPS, version 5.0, will be the CLIPS Object Oriented Language (COOL). The major capabilities of COOL are: class definition with multiple inheritance and no restrictions on the number, types, or cardinality of slots; message passing which allows procedural code bundled with an object to be executed; and query functions which allow groups of instances to be examined and manipulated. In addition to COOL, numerous other enhancements were added to CLIPS including: generic functions (which allow different pieces of procedural code to be executed depending upon the types or classes of the arguments); integer and double precision data type support; multiple conflict resolution strategies; global variables; logical dependencies; type checking on facts; full ANSI compiler support; and incremental reset for rules. Author

**N91-20700*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**PARALLEL PROCESSING AND EXPERT SYSTEMS c62**
Jerry C. Yan (Sterling Federal Systems, Inc., Moffett Field, CA.) and Sonie Lau *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 469-476 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

Whether it be monitoring the thermal subsystem of Space Station Freedom, or controlling the navigation of the autonomous rover on Mars, NASA missions in the 90's cannot enjoy an increased level of autonomy without the efficient use of expert systems. Merely increasing the computational speed of uniprocessors may not be able to guarantee that real time demands are met for large expert systems. Speed-up via parallel processing must be pursued alongside the optimization of sequential implementations. Prototypes of parallel expert systems have been built at universities and industrial labs in the U.S. and Japan. The state-of-the-art research in progress related to parallel execution of expert systems was surveyed. The survey is divided into three major sections: (1) multiprocessors for parallel expert systems; (2) parallel languages for symbolic computations; and (3) measurements of parallelism of expert system. Results to date indicate that the parallelism achieved for these systems is small. In order to obtain greater speed-ups, data parallelism and application parallelism must be exploited. Author

**N91-20701*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**THE ADVANCED SOFTWARE DEVELOPMENT WORKSTATION PROJECT c61**
Ernest M. Fridge, III and Charles L. Pitman *In its* Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 477-480 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

The Advanced Software Development Workstation (ASDW) task is researching and developing the technologies required to support Computer Aided Software Engineering (CASE) with the emphasis on those advanced methods, tools, and processes that will be of benefit to support all NASA programs. Immediate goals are to provide research and prototype tools that will increase productivity, in the near term, in projects such as the Software Support Environment (SSE), the Space Station Control Center (SSCC), and the Flight Analysis and Design System (FADS) which will be used to support the Space Shuttle and Space Station Freedom. Goals also include providing technology for development, evolution, maintenance, and operations. The technologies under research and development in the ASDW project are targeted to provide productivity enhancements during the software life cycle phase of enterprise and information system modeling, requirements generation and analysis, system design and coding, and system use and maintenance. On-line user's guides will assist users in operating the developed information system with knowledge base expert assistance. Author

**N91-20702*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**FOURTH ANNUAL WORKSHOP ON SPACE OPERATIONS APPLICATIONS AND RESEARCH (SOAR 90)**
Robert T. Savely, ed. Washington Jan. 1991 316 p Workshop held in Albuquerque, NM, 26-28 Jun. 1990; sponsored by NASA, Washington, AF, and New Mexico Univ.
(NASA-CP-3103-Vol-2; S-618-Vol-2; NAS 1.55:3103-Vol-2) Avail: NTIS HC/MF A14 CSCL 12A

The papers from the symposium are presented. Emphasis is placed on human factors engineering and space environment interactions. The technical areas covered in the human factors section include: satellite monitoring and control, man-computer interfaces, expert systems, AI/robotics interfaces, crew system dynamics, and display devices. The space environment interactions section presents the following topics: space plasma interaction, spacecraft contamination, space debris, and atomic oxygen interaction with materials. Some of the above topics are discussed in relation to the space station and space shuttle. For individual titles, see N91-20703 through N91-20738.

**N91-20703*#** Air Force Systems Command, Norton AFB, CA. Space Systems Div.

**A HUMAN FACTORS APPROACH TO RANGE SCHEDULING FOR SATELLITE CONTROL** **c54**

Cameron H. G. Wright and Donald J. Aitken *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 484-489 (For primary document see N91-20702 12-59)

(Contract F04701-86-C-0007)

Avail: NTIS HC/MF A14 CSCL 05H

Range scheduling for satellite control presents a classical problem: supervisory control of a large-scale dynamic system, with unwieldy amounts of interrelated data used as inputs to the decision process. Increased automation of the task, with the appropriate human-computer interface, is highly desirable. The development and user evaluation of a semi-automated network range scheduling system is described. The system incorporates a synergistic human-computer interface consisting of a large screen color display, voice input/output, a 'sonic pen' pointing device, a touchscreen color CRT, and a standard keyboard. From a human factors standpoint, this development represents the first major improvement in almost 30 years to the satellite control network scheduling task. Author

**N91-20704*#** Georgia State Univ., Atlanta. Center for Human-Machine Systems Research.

**MODEL-BASED DISPLAYS FOR SATELLITE GROUND CONTROL** **c81**

Christine M. Mitchell *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 490-492 (For primary document see N91-20702 12-59)

(Grant NAG5-1044)

Avail: NTIS HC/MF A14 CSCL 05A

With the emergence of new technology for both human-computer interaction and knowledge-based systems, a range of opportunities exists to enhance the effectiveness and efficiency of satellite ground controllers. The use of models of operator function to represent operator activity in the context of changing system events and operator functions is illustrated. Although there are many models, the operator function model (OFM) was used in this research. In addition to representing operator activities, the OFM can be used to design 'intelligent' operator displays and, in real time, control the displayed information so that the operator has the appropriate information, at the appropriate time, and at the appropriate level of abstraction. The OFM was demonstrated in the context of a NASA Goddard Space Flight Center satellite ground control system. To evaluate the effectiveness of the model-based workstation, an experiment was conducted to compare system performance with a conventional operator workstation versus the model based workstation. Author

**N91-20705*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

**UTILIZING EXPERT SYSTEMS FOR SATELLITE MONITORING AND CONTROL** **c18**

Peter M. Hughes *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 493-498 (For primary document see N91-20702 12-59)

Avail: NTIS HC/MF A14 CSCL 22B

Spacecraft analysts in the spacecraft control center for the Cosmic Background Explorer (COBE) satellite are currently utilizing a fault-isolation expert system developed to assist in the isolation and correction of faults in the communications link. This system, the communication link expert assistance resource (CLEAR), monitors real time spacecraft and ground systems performance parameters in search of configuration discrepancies and communications link problems. If such a discrepancy or problem is isolated, CLEAR alerts the analyst and provides advice on how to resolve the problem swiftly and effectively. The CLEAR system is the first real time expert system to be used in the operational environment of a satellite control center at the NASA Goddard Space Flight Center. Clear has not only demonstrated the utility and potential of an expert system in the demanding environment of a satellite control center, but also has revealed many of the pitfalls and deficiencies of development of expert systems. One of the lessons learned from this and other initial expert system projects is that prototypes can often be developed quite rapidly, but operational expert systems require considerable effort. Development is generally a slow, tedious process that typically requires the special skills of trained programmers. Due to the success of CLEAR and several other systems in the control center domain, a large number of expert systems will certainly be developed to support control center operations during the early 1990's. To facilitate the development of these systems, a project was initiated to develop an integrated, domain-specific tool, the generic spacecraft analyst assistent (GenSAA), that alows the spacecraft analysts to rapidly create simple expert systems themselves. By providing a highly graphical point-and-select method of system development, GenSAA allows the analyst to utilize and/or modify previously developed rule bases and system components; thus, facilitating software reuse and reducing development time and effort. Author

**N91-20706*#** Georgia State Univ., Atlanta. Center for Human-Machine Systems Research.

**ALLY: AN OPERATOR'S ASSOCIATE FOR SATELLITE GROUND CONTROL SYSTEMS** **c63**

J. B. Bushman, Christine M. Mitchell, P. M. Jones, and K. S. Rubin *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 499-506 (For primary document see N91-20702 12-59)

(Contract NAS5-28575; NAG2-413)

Avail: NTIS HC/MF A14 CSCL 09B

The key characteristics of an intelligent advisory system is explored. A central feature is that human-machine cooperation should be based on a metaphor of human-to-human cooperation. ALLY, a computer-based operator's associate which is based on a preliminary theory of human-to-human cooperation, is discussed. ALLY assists the operator in carrying out the supervisory control functions for a simulated NASA ground control system. Experimental evaluation of ALLY indicates that operators using ALLY performed at least as well as they did when using a human associate and in some cases even better. Author

**N91-20707*#** Oregon State Univ., Corvallis. Dept. of Industrial and Manufacturing Engineering.

**COCKPIT TASK MANAGEMENT: A PRELIMINARY, NORMATIVE THEORY** **c54**

Ken Funk *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 508-520 (For primary document see N91-20702 12-59)

Avail: NTIS HC/MF A14 CSCL 05H

Cockpit task management (CTM) involves the initiation, monitoring, prioritizing, and allocation of resources to concurrent tasks as well as termination of multiple concurrent tasks. As aircrews have more tasks to attend to due to reduced crew sizes and the increased complexity of aircraft and the air transportation system, CTM will become a more critical factor in aviation safety. It is clear that many aviation accidents and incidents can be satisfactorily explained in terms of CTM errors, and it is likely that more accidents induced by poor CTM practice will occur in the future unless the issue is properly addressed. The first step in understanding and facilitating CTM behavior was the development of a preliminary, normative theory of CTM which identifies several important CTM functions. From this theory, some requirements for pilot-vehicle interfaces were developed which are believed to facilitate CTM. A prototype PVI was developed which improves CTM performance and currently, a research program is under way that is aimed at developing a better understanding of CTM and facilitating CTM performance through better equipment and procedures. Author

**N91-20708*#** Georgia State Univ., Atlanta. Center for Human-Machine Systems Research.

**OFMSPERT: AN ARCHITECTURE FOR AN OPERATOR'S ASSOCIATE THAT EVOLVES TO AN INTELLIGENT TUTOR** **c63**

Christine M. Mitchell *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 522-526 (For primary document see N91-20702 12-59)
(Grants NAG2-413; NAG5-1044)
Avail: NTIS HC/MF A14 CSCL 09B

With the emergence of new technology for both human-computer interaction and knowledge-based systems, a range of opportunities exist which enhance the effectiveness and efficiency of controllers of high-risk engineering systems. The design of an architecture for an operator's associate is described. This associate is a stand-alone model-based system designed to interact with operators of complex dynamic systems, such as airplanes, manned space systems, and satellite ground control systems in ways comparable to that of a human assistant. The operator function model expert system (OFMspert) architecture and the design and empirical validation of OFMspert's understanding component are described. The design and validation of OFMspert's interactive and control components are also described. A description of current work in which OFMspert provides the foundation in the development of an intelligent tutor that evolves to an assistant, as operator expertise evolves from novice to expert, is provided. Author

**N91-20709*#** South Dakota Univ., Vermillion. Human Factors Lab.

**ENHANCING THE USABILITY OF CRT DISPLAYS IN TEST FLIGHT MONITORING** **c35**

Michael M. Granaas and Victoria E. Sredinski *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 529-534 (For primary document see N91-20702 12-59)
(Grant NAG2-492)
Avail: NTIS HC/MF A14 CSCL 14B

Enhancing the usability of Mission Control Center (MCC) CRT displays stands to improve the quality, productivity, and safety of flight-test research at the NASA Ames-Dryden Flight Research Facility. The results of this research suggests that much can be done to assist the user and improve the quality of flight research through the enhancement of current displays. This research has applications to a variety of flight data monitoring displays.
Author

**N91-20710*#** Aerospace Medical Research Labs., Wright-Patterson AFB, OH.

**A SPATIAL DISORIENTATION PREDICTOR DEVICE TO ENHANCE PILOT SITUATIONAL AWARENESS REGARDING AIRCRAFT ATTITUDE** **c01**

T. L. Chelette, Daniel W. Repperger, and W. B. Albery *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 536-541 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 01D

An effort was initiated at the Armstrong Aerospace Medical Research Laboratory (AAMRL) to investigate the improvement of the situational awareness of a pilot with respect to his aircraft's spatial orientation. The end product of this study is a device to alert a pilot to potentially disorienting situations. Much like a ground collision avoidance system (GCAS) is used in fighter aircraft to alert the pilot to 'pull up' when dangerous flight paths are predicted, this device warns the pilot to put a higher priority on attention to the orientation instrument. A Kalman filter was developed which estimates the pilot's perceived position and orientation. The input to the Kalman filter consists of two classes of data. The first class of data consists of noise parameters (indicating parameter uncertainty), conflict signals (e.g. vestibular and kinesthetic signal disagreement), and some nonlinear effects. The Kalman filter's perceived estimates are now the sum of both Class 1 data (good information) and Class 2 data (distorted information). When the estimated perceived position or orientation is significantly different from the actual position or orientation, the pilot is alerted.
Author

**N91-20711*#** Ohio State Univ., Columbus. Cognitive Systems Engineering Lab.

**COGNITIVE CONSEQUENCES OF CLUMSY AUTOMATION ON HIGH WORKLOAD, HIGH CONSEQUENCE HUMAN PERFORMANCE** **c54**

Richard I. Cook, David D. Woods, Elizabeth McColligan, and Michael B. Howie *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 543-546 (For primary document see N91-20702 12-59)
(Contract NCC2-592)
Avail: NTIS HC/MF A14 CSCL 05H

The growth of computational power has fueled attempts to automate more of the human role in complex problem solving domains, especially those where system faults have high consequences and where periods of high workload may saturate the performance capacity of human operators. Examples of these domains include flightdecks, space stations, air traffic control, nuclear power operation, ground satellite control rooms, and surgical operating rooms. Automation efforts may have unanticipated effects on human performance, particularly if they increase the workload at peak workload times or change the practitioners' strategies for coping with workload. Smooth and effective changes in automation requires detailed understanding of the congnitive tasks confronting the user: it has been called user centered automation. The introduction of a new computerized technology in a group of hospital operating rooms used for heart surgery was observed. The study revealed how automation, especially 'clumsy automation', effects practitioner work patterns and suggest that clumsy automation constrains users in specific and significant ways. Users tailor both the new system and their tasks in order to accommodate the needs of process and production. The study of this tailoring may prove a powerful tool for exposing previously hidden patterns of user data processing, integration, and decision making which may, in turn, be useful in the design of more effective human-machine systems. Author

**N91-20712*#** Ohio State Univ., Columbus. Cognitive Systems Engineering Lab.

**GUIDANCE FOR HUMAN INTERFACE WITH ARTIFICIAL INTELLIGENCE SYSTEMS** **c63**

Scott S. Potter and David D. Woods *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 547-549 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 09B

The beginning of a research effort to collect and integrate existing research findings about how to combine computer power and people is discussed, including problems and pitfalls as well as desirable features. The goal of the research is to develop guidance for the design of human interfaces with intelligent systems. Fault management tasks in NASA domains are the focus of the investigation. Research is being conducted to support the development of guidance for designers that will enable them to make human interface considerations into account during the creation of intelligent systems. Author

**N91-20713*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

**DEVELOPMENT OF BIOMECHANICAL MODELS FOR HUMAN FACTORS EVALUATIONS** **c64**

Barbara Woolford, Abhilash Pandya, and James Maida (Lockheed Engineering and Sciences Co., Houston, TX.) *In its* Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 552-556 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 12A

Previewing human capabilities in a computer-aided engineering mode has assisted greatly in planning well-designed systems without the cost and time involved in mockups and engineering models. To date, the computer models have focused on such variables as field of view, accessibility and fit, and reach envelopes. Program outputs have matured from simple static pictures to animations viewable from any eyepoint. However, while kinematics models are available, there are few biomechanical models available for estimating strength and motion patterns. Those, such as Crew Chief, that are available are based on strength measurements taken in specific positions. Johnson Space Center is pursuing a biomechanical model which will use strength data collected on single joints at two or three velocities to attempt to predict compound motions of several joint simultaneously and the resulting force at the end effector. Two lines of research are coming together to produce this result. One is an attempt to use optimal control theory to predict joint motion in complex motions, and another is the development of graphical representation of human capabilities. The progress to date in this research is described. Author

**N91-20714*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**RECOVERY FROM AN ANOMALOUS THRUSTER INPUT DURING A SIMULATED DOCKING MANEUVER** **c18**

Adam R. Brody (Sterling Software, Moffett Field, CA.) and Stephen R. Ellis *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 557-560 (For primary document see N91-20702 12-59)

Avail: NTIS HC/MF A14 CSCL 22B

An experiment was performed in the Space Station Proximity Operations Simulator at the NASA Ames Research Center. Five test subjects were instructed to perform twenty simulated remote docking maneuvers of an orbital maneuvering vehicle (OMV) to the space station in which they were located. The OMV started from an initial range of 304.8 m (1000 ft) on the space station's negative velocity vector. Anomalous out-of-plane thruster firings of various magnitudes (simulating a faulty thruster) occurred at one of five ranges from the target. Initial velocity, range of anomalous burn, and magnitude of anomalous burn were the factors varied. In addition to whether the trial was successful, time and fuel to return to a nominal trajectory, total mission duration, total fuel consumption, and time histories of commanded burns were recorded. Analysis of the results added support to the hypothesis that slow approach velocities are not inherently safer than their more rapid counterparts. Naive subjects were capable of docking successfully at velocities faster than those prescribed by the 0.1 percent rule even when a simulated faulty thruster disturbed the nominal trajectory. Little to no justification for slow approach velocities remains from a human factors standpoint. Author

**N91-20715*#** Ocean Systems Engineering, Inc., Falls Church, VA.

**CONSIDERATIONS FOR HUMAN-MACHINE INTERFACES IN TELE-OPERATIONS** **c05**

Curt Newport *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 561-568 (For primary document see N91-20702 12-59)

Avail: NTIS HC/MF A14 CSCL 05H

Numerous factors impact on the efficiency of tele-operative manipulative work. Generally, these are related to the physical environment of the tele-operator and how he interfaces with robotic control consoles. The capabilities of the operator can be influenced by considerations such as temperature, eye strain, body fatigue, and boredom created by repetitive work tasks. In addition, the successful combination of man and machine will, in part, be determined by the configuration of the visual and physical interfaces available to the teleoperator. The design and operation of system components such as full-scale and mini-master manipulator controllers, servo joysticks, and video monitors will have a direct impact on operational efficiency. As a result, the local environment and the interaction of the operator with the robotic control console have a substantial effect on mission productivity. Author

**N91-20716*#** Lockheed Engineering and Sciences Co., Houston, TX.

**THE USE OF ANALYTICAL MODELS IN HUMAN-COMPUTER INTERFACE DESIGN** **c60**

Leo Gugerty *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 574-581 (For primary document see N91-20702 12-59)

Avail: NTIS HC/MF A14 CSCL 09B

Some of the many analytical models in human-computer interface design that are currently being developed are described. The usefulness of analytical models for human-computer interface design is evaluated. Can the use of analytical models be recommended to interface designers? The answer, based on the empirical research summarized here, is: not at this time. There are too many unanswered questions concerning the validity of models and their ability to meet the practical needs of design organizations. Author

**N91-20717*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

**MICROGRAVITY CURSOR CONTROL DEVICE EVALUATION FOR SPACE STATION FREEDOM WORKSTATIONS** **c18**

Susan Adam, Kritina L. Holden, Douglas Gillan (Lockheed Engineering and Sciences Co., Houston, TX.), and Marianne Rudisill *In its* Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 582-587 (For primary document see N91-20702 12-59)

Avail: NTIS HC/MF A14 CSCL 22B

This research addressed direct manipulation interface (curser-controlled device) usability in microgravity. The data discussed are from KC-135 flights. This included pointing and dragging movements over a variety of angles and distances. Detailed error and completion time data provided researchers with information regarding cursor control shape, selection button arrangement, sensitivity, selection modes, and considerations for future research. Author

**N91-20718*#** Lockheed Engineering and Sciences Co., Houston, TX.

**DEVELOPING THE HUMAN-COMPUTER INTERFACE FOR SPACE STATION FREEDOM** **c60**

Kritina L. Holden *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 588-594 (For primary document see N91-20702 12-59)

Avail: NTIS HC/MF A14 CSCL 09B

For the past two years, the Human-Computer Interaction Laboratory (HCIL) at the Johnson Space Center has been involved in prototyping and prototype reviews of in support of the definition phase of the Space Station Freedom program. On the Space Station, crew members will be interacting with multi-monitor workstations where interaction with several displays at one time will be common. The HCIL has conducted several experiments to begin to address design issues for this complex system. Experiments have dealt with design of ON/OFF indicators, the movement of the cursor across multiple monitors, and the importance of various windowing capabilities for users performing multiple tasks simultaneously. Author

**N91-20719*#** Lockheed Engineering and Sciences Co., Houston, TX.

**SPACECRAFT CREW PROCEDURES FROM PAPER TO COMPUTERS** **c54**

Michael ONeal and Meera Manahan *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 595-600 (For primary document see N91-20702 12-59)

(Contract NAS9-17900)
Avail: NTIS HC/MF A14 CSCL 05H

Described here is a research project that uses human factors and computer systems knowledge to explore and help guide the design and creation of an effective Human-Computer Interface (HCI) for spacecraft crew procedures. By having a computer system behind the user interface, it is possible to have increased procedure automation, related system monitoring, and personalized annotation and help facilities. The research project includes the development of computer-based procedure system HCI prototypes and a testbed for experiments that measure the effectiveness of HCI alternatives in order to make design recommendations. The testbed will include a system for procedure authoring, editing, training, and execution. Progress on developing HCI prototypes for a middeck experiment performed on Space Shuttle Mission STS-34 and for upcoming medical experiments are discussed. The status of the experimental testbed is also discussed. Author

**N91-20720*#** Miami Univ., Coral Gables, FL. Dept. of Psychology.

**ELECTRONIC COLLABORATION: SOME EFFECTS OF TELECOMMUNICATION MEDIA AND MACHINE INTELLIGENCE ON TEAM PERFORMANCE** **c63**

A. Rodney Wellens *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 606-611 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 09B

Both NASA and DoD have had a long standing interest in teamwork, distributed decision making, and automation. While research on these topics has been pursued independently, it is becoming increasingly clear that the integration of social, cognitive, and human factors engineering principles will be necessary to meet the challenges of highly sophisticated scientific and military programs of the future. Images of human/intelligent-machine electronic collaboration were drawn from NASA and Air Force reports as well as from other sources. Here, areas of common concern are highlighted. A description of the author's research program testing a 'psychological distancing' model of electronic media effects and human/expert system collaboration is given. Author

**N91-20721*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**ISSUES ON COMBINING HUMAN AND NON-HUMAN INTELLIGENCE** **c63**

Irving C. Statler and Mary M. Connors *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 612-619 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 09B

The purpose here is to call attention to some of the issues confronting the designer of a system that combines human and non-human intelligence. We do not know how to design a non-human intelligence in such a way that it will fit naturally into a human organization. The author's concern is that, without adequate understanding and consideration of the behavioral and psychological limitations and requirements of the human member(s) of the system, the introduction of artificial intelligence (AI) subsystems can exacerbate operational problems. We have seen that, when these technologies are not properly applied, an overall degradation of performance at the system level can occur. Only by understanding how human and automated systems work together can we be sure that the problems introduced by automation are not more serious than the problems solved. Author

**N91-20722*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

**ANALYSIS OF THE INDIVIDUAL RISK OF ALTITUDE DECOMPRESSION SICKNESS UNDER REPEATED EXPOSURES** **c52**

K. Vasantha Kumar, David J. Horrigan, James M. Waligora, and John H. Gilbert (Space Biomedical Research Inst., Houston, TX.) *In its* Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 633-636 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 06P

In a case-control study, researchers examined the risk of decompression sickness (DCS) in individual subjects with higher number of exposures. Of the 126 subjects, 42 showed one or more episodes of DCS. Examination of the exposure-DCS relationship by odds ratio showed a linear relationship. Stratification analysis showed that sex, tissue ratio, and the presence of Doppler microbubbles were cofounders of this risk. A higher number of exposures increased the risk of DCS in this analysis. Author

**N91-20723*#** Toronto Univ. (Ontario). Dept. of Electrical Engineering.

**MAGNETOPLASMA SHEATH WAVES ON A CONDUCTING TETHER IN THE IONOSPHERE WITH APPLICATIONS TO EMI PROPAGATION ON LARGE SPACE STRUCTURES** **c32**

K. G. Balmain, H. G. James (Communications Research Centre, Ottawa, Ontario ), and C. C. Bantin *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 646-654 Sponsored in part by National Research Council of Canada; Natural Sciences and Engineering Research Council of Canada; and Institute for Space and Terrestrial Science, Ontario (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 17B

A recent space experiment confirmed sheath-wave propagation of a kilometer-long insulated wire in the ionosphere, oriented parallel to the Earth's magnetic field. This space tether experiment, Oedipus-A, showed a sheath-wave passband up to about 2 MHz and a phase velocity somewhat slower than the velocity of light in a vacuum, and also demonstrated both ease of wave excitation and low attenuation. The evidence suggests that, on any large structure in low Earth orbit, transient or continuous wave electromagnetic interference, once generated, could propagate over the structure via sheath waves, producing unwanted signal levels much higher than in the absence of the ambient plasma medium. Consequently, there is a need for a review of both electromagnetic interference/electromagnetic compatibility standards and ground test procedures as they apply to large structures in low Earth orbit. Author

**N91-20724*#** Sverdrup Technology, Inc., Brook Park, OH.

**THE SOLAR ARRAY MODULE PLASMA INTERACTIONS EXPERIMENT (SAMPIE): A SHUTTLE-BASED PLASMA INTERACTION EXPERIMENT** **c20**

G. Barry Hillard *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 655-662 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 10A

The SAMPIE flight experiment, tentatively scheduled to fly on a shuttle mission in mid 1992, will investigate plasma interactions of high voltage space power systems. Solar cells representing a number of technologies will be biased to high voltage to study both negative potential arching and positive potential current collection characteristics. Additionally, several idealized metal/insulator mockups will be flown to study the basic nature of these interactions. Described here is the basic rationale for a space experiment as well as the measurements to be made and the significance of the expected results. The current design status of the flight hardware is presented. Author

**N91-20725*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

**ENVIRONET: AN ONLINE ENVIRONMENTAL INTERACTIONS RESOURCE** **c66**

Michael Lauriente *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 668-673 Sponsored by

NASA, Washington; AFGL; and AFSC (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 12B

EnviroNET is a centralized depository for technical information on environmentally induced interactions likely to be encountered by spacecraft in both low-altitude and high-altitude orbits. It provides a user-friendly, menu-driven format on networks that are connected globally and is available 24 hours a day - every day. The service pools space data collected over the years by NASA, USAF, other government research facilities, industry, universities, and the European Space Agency. This information contains text, tables and over one hundred high resolution figures and graphs based on empirical data. These graphics can be accessed while still in the chapters, making it easy to flip from text to graphics and back. Interactive graphics programs are also available on space debris, the neutral atmosphere, magnetic field, and ionosphere. EnviroNET can help designers meet tough environmental flight criteria before committing to flight hardware built for experiments, instrumentation, or payloads. Author

**N91-20726*#** Air Force Geophysics Lab., Hanscom AFB, MA. Space Physics Div.
**PHOTOMETRIC ANALYSIS OF A SPACE SHUTTLE WATER VENTING** **c18**
R. A. Viereck, E. Murad, C. P. Pike, I. L. Kofsky, C. A. Trowbridge, D. L. A. Rall, A. Satayesh, A. Berk, and J. B. Elgin (Spectral Sciences, Inc., Burlington, MA.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 676-680 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 22B

Presented here is a preliminary interpretation of a recent experiment conducted on Space Shuttle Discovery (Mission STS 29) in which a stream of liquid supply water was vented into space at twilight. The data consist of video images of the sunlight-scattering water/ice particle cloud that formed, taken by visible light-sensitive intensified cameras both onboard the spacecraft and at the AMOS ground station near the trajectory's nadir. This experiment was undertaken to study the phenomenology of water columns injected into the low-Earth orbital environment, and to provide information about the lifetime of ice particles that may recontact Space Shuttle orbits later. The findings about the composition of the cloud have relevance to ionospheric plasma depletion experiments and to the dynamics of the interaction of orbiting spacecraft with the environment. Author

**N91-20727*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**THE ENVIRONMENT WORKBENCH: A DESIGN TOOL FOR SPACE STATION FREEDOM** **c18**
Gary A. Jongeward, Robert A. Kuharski, Thomas V. Rankin, Katherine G. Wilcox (Systems Science and Software, La Jolla, CA.), and James C. Roche *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 684-687 (For primary document see N91-20702 12-59)
(Contract NAS3-25347)
Avail: NTIS HC/MF A14 CSCL 22B

The environment workbench (EWB) is being developed for NASA by S-CUBED to provide a standard tool that can be used by the Space Station Freedom (SSF) design and user community for requirements verification. The desktop tool will predict and analyze the interactions of SSF with its natural and self-generated environments. A brief review of the EWB design and capabilities is presented. Calculations using a prototype EWB of the on-orbit floating potentials and contaminant environment of SSF are also presented. Both the positive and negative grounding configurations for the solar arrays are examined to demonstrate the capability of the EWB to provide quick estimates of environments, interactions, and system effects. Author

**N91-20728*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**FINDINGS OF THE JOINT WORKSHOP ON EVALUATION OF IMPACTS OF SPACE STATION FREEDOM GROUND CONFIGURATIONS** **c18**
Dale C. Ferguson, David B. Snyder, and Ralph Carruth (National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 689-694 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 22B

At the workshop, experts from the plasma interactions community evaluated the impacts of environmental interactions on the Space Station Freedom (SSF) under each of the proposed grounding schemes. The grounding scheme chosen for the SSF power system was found to have serious implications for SSF design. Interactions of the SSF power system and structure with the low Earth orbit (LEO) plasma differ significantly between different proposed grounding schemes. Environmental constraints will require modification of current SSF designs under any grounding scheme. Maintaining the present negative-grounding scheme compromises SSF safety, structural integrity, and electromagnetic compatibility. It also will increase contamination rates over alternative grounding schemes. One alternative, positive grounding of the array, requires redesign of the primary power system in work package four. Floating the array reduces the number of circuit changes to work package four but adds new hardware. Maintaining the current design will affect all work packages; however, no impacts were identified on work packages one, two, or three by positively grounding or floating the array, with the possible exception of extra corona protection in multi-wire connectors. Author

**N91-20729*#** Space Command, Peterson AFB, CO.
**SMALL SATELLITE DEBRIS CATALOG MAINTENANCE ISSUES** **c12**
Phoebe A. Jackson *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 696-704 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 22A

The United States Space Command (USSPACECOM) is a unified command of the Department of Defense, and one of its tasks is to detect, track, identify, and maintain a catalog of all man-made objects in Earth orbit. This task is called space surveillance, and the most important tool for space surveillance is the satellite catalog. The command's reasons for performing satellite catalog maintenance is presented. A satellite catalog is described, and small satellite-debris catalog-maintenance issues are identified. The underlying rationale is to describe the catalog maintenance services so that the members of the community can use them with assurance. Author

**N91-20730*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**THE IMPORTANCE OF MOMENTUM TRANSFER IN COLLISION-INDUCED BREAKUPS IN LOW EARTH ORBIT** **c12**
Robert C. Reynolds and Brian J. Lillie *In its* Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 706-717 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 22A

Although there is adequate information on larger objects in low Earth orbit, specifically those objects larger than about 10 cm in diameter, there is little direct information on objects from this size down to 1 mm. Yet, this is the sized regime where objects acting as projectiles represent the ability to seriously damage or destroy a functioning spacecraft if they collide with it. The observed consequences of known collisional breakups in orbit indicates no significant momentum transfer in the resulting debris cloud. The position taken in this paper is that this is an observational selection effect: what is seen in these events is an explosion-like breakup

of the target structure arising from shock waves introduced into the structure by the collision, but one that occurs significantly after the collision processes are completed; the collision cloud, in which there is momentum transfer, consists of small, unobserved fragments. Preliminary computations of the contribution of one known collisional breakup, Solwind at 500 km in 1985, and Cosmos 1275 in 1981, assume no momentum transfer on breakup and indicate that these two events are the dominant contributors to the current millimeter and centimeter population. A different story would emerge if momentum transfer was taken into account. The topics covered include: (1) observation of on-orbit collisional breakups; (2) a model for momentum transfer; and (3) velocity space representation of breakup clouds. Author

**N91-20731*#** Naval Space Surveillance System, Dahlgren, VA. Dept. of Analysis and Software.

**NAVSPASUR ORBITAL PROCESSING FOR SATELLITE BREAK-UP EVENTS** **c12**

Paul W. Schumacher, Jr. *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 718-723 (For primary document see N91-20702 12-59)

Avail: NTIS HC/MF A14 CSCL 22A

Satellite breakups via explosion or collision can instantly increase the trackable orbiting population by up to several hundred objects, temporarily perturbing the routine space surveillance operations at U.S. Space Command (USSPACWCOM) and the Naval Space Surveillance Center (NAVSPASUR). This paper is a survey of some of the procedures and techniques used by NAVSPASUR to respond to such events. First, the overall data flow at NAVSPASUR is described highlighting the places at which human analysts may intervene with special processing. So-called manual intervention is required in a variety of non-nominal situations, including breakups. Second, a description is given of some of the orbital analysis and other software tools available to NAVSPASUR analysts. These tools were developed in-house over the past thirty years and can be employed in a highly flexible manner. The basic design philosophy for these tools was to implement simple concepts as efficiently as possible and to allow the analyst maximum use of his personal expertise. Finally, several historical breakup scenarios are discussed briefly. These scenarios provide examples of the types of questions that are fairly easy to answer in the present operational environment, as well as examples of questions that are very difficult to answer. Author

**N91-20732*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**ATOMIC OXYGEN INTERACTION WITH SOLAR ARRAY BLANKETS AT PROTECTIVE COATING DEFECT SITES** **c44**

Bruce A. Banks, Bruce M. Auer, Sharon K. Rutledge, and Carol M. Hill (Case Western Reserve Univ., Cleveland, OH.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 726-732 (For primary document see N91-20702 12-59)

Avail: NTIS HC/MF A14 CSCL 10A

Atomic oxygen in the low-Earth-orbital environment oxidizes SiOx protected polyimide Kapton solar array blankets at sites which are not protected such as pin windows or scratches in the protective coatings. The magnitude and shape of the atomic oxygen undercutting which occurs at these sites is dependent upon the exposure environment details such as arrival direction and reaction probability. The geometry of atomic oxygen undercutting at defect sites exposed to atomic oxygen in plasma asher was used to develop a Monte Carlo model to simulate atomic oxygen erosion processes at defect sites in protected Kapton. Comparisons of Monte Carlo predictions and experimental results are presented for plasma asher atomic oxygen exposures for large and small defects as well as for protective coatings on one or both sides of Kapton. The model is used to predict in-space exposure results at defect sites for both directed and sweeping atomic oxygen exposure. A comparison of surface textures predicted by the Monte Carlo model and those experimentally observed from both directed space ram and laboratory plasma asher atomic oxygen exposure indicate substantial agreement. Author

**N91-20733*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

**ATOMIC OXYGEN BEAM SOURCE FOR EROSION SIMULATION** **c72**

J. W. Cuthbertson, W. D. Langer, R. W. Motley (Princeton Univ., NJ.), and J. A. Vaughn *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 734-741 (For primary document see N91-20702 12-59)

(NASA Order H-83097-B)

Avail: NTIS HC/MF A14 CSCL 20H

A device for the production of low energy (3 to 10 eV) neutral atomic beams for surface modification studies is described that reproduces the flux of atomic oxygen in low Earth orbit. The beam is produced by the acceleration of plasma ions onto a negatively biased plate of high-Z metal; the ions are neutralized and reflected by the surface, retaining some fraction of their incident kinetic energy, forming a beam of atoms. The plasma is generated by a coaxial RF exciter which produces a magnetically-confined (4 kG) plasma column. At the end of the column, ions fall through the sheath to the plate, whose bias relative to the plasma can be varied to adjust the beam energy. The source provides a neutral flux approximately equal to 5 x 10(exp 16)/sq cm at a distance of 9 cm and a fluence approximately equal to 10(exp 20)/sq cm in five hours. The composition and energy of inert gas beams was diagnosed using a mass spectometer/energy analyzer. The energy spectra of the beams demonstrate energies in the range 5 to 15 eV, and qualitatively show expected dependences upon incident and reflecting atom species and potential drop. Samples of carbon film, carbon-based paint, Kapton, mylar, and teflon exposed to atomic O beams show erosion quite similar to that observed in orbit on the space shuttle. Author

**N91-20734*#** Lockheed Aircraft Corp., Palo Alto, CA. Research and Development Div.

**LABORATORY INVESTIGATION OF VISIBLE SHUTTLE GLOW MECHANISMS** **c16**

A. Leone, G. R. Swenson, G. E. Caledonia, and K. W. Holtzclaw (Physical Sciences, Inc., Andover, MA.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 743-751 (For primary document see N91-20702 12-59)

Avail: NTIS HC/MF A14 CSCL 22B

Laboratory experiments designed to uncover mechanistic information about the spectral and spatial characteristics of shuttle glow were conducted. The luminescence was created when a pulse of O atoms traveling at orbital velocities was directed toward NO molecules previously adsorbed to aluminum, nickel, and Z306 Chemglaz (a common baffle black) coated surfaces held at various temperatures. Spectral and spatial measurements were made using a CCD imaging spectrometer. Corroborative spectral information was recorded in separate measurements using a scanning monochromator and gated photomultiplier arrangement. The e-folding distance at several temperatures was calculated from images of the surface glow using the photometrics image processing capability of the imaging spectrometer. The e-folding distance was not altered as a function of incoming O beam velocity. The results are presented and the observations provide direct evidence that the visible shuttle glow results from recombination of oxygen atoms and surface bound NO. Author

**N91-20735*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**THE EFFECT OF ATOMIC OXYGEN ON POLYSILOXANE-POLYIMIDE FOR SPACECRAFT APPLICATIONS IN LOW EARTH ORBIT** **c72**

Sharon K. Rutledge, Jill M. Cooper, and Raymond M. Olle (Cleveland State Univ., OH.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations

Applications and Research (SOAR 90) Jan. 1991 p 755-762 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 20H

Polysiloxane-polyimide films are of interest as a replacement for polyimide Kapton in the Space Station Freedom solar array blanket. The blanket provides the structural support for the solar cells as well as providing transport of heat away from the back of the cells. Polyimide Kapton would be an ideal material to use; however, its high rate of degradation due to attack by atomic oxygen in low Earth orbit, at the altitudes Space Station Freedom will fly, is of such magnitude that if left unprotected, the blanket will undergo structural failure in much less than the desired 15 year operating life. Polysiloxane-polyimide is of interest as a replacement material because it should from its own protective silicon dioxide coating upon exposure to atomic oxygen. Mass, optical, and photomicrographic data obtained in the evaluation of the durability of polysiloxane-polyimide to an atomic oxygen environment are presented. Author

**N91-20736*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**CHARACTERIZATION OF A 5-eV NEUTRAL ATOMIC OXYGEN BEAM FACILITY** **c72**
J. A. Vaughn, R. C. Linton, M. R. Carruth, Jr., A. F. Whitaker, J. W. Cuthbertson, W. D. Langer, and R. W. Motley (Princeton Univ., NJ.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 764-771 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 20H

An experimental effort to characterize an existing 5-eV neutral atomic oxygen beam facility being developed at Princeton Plasma Physics Laboratory is described. This characterization effort includes atomic oxygen flux and flux distribution measurements using a catalytic probe, energy determination using a commercially designed quadrupole mass spectrometer (QMS), and the exposure of oxygen-sensitive materials in this beam facility. Also, comparisons were drawn between the reaction efficiencies of materials exposed in plasma ashers, and the reaction efficiencies previously estimated from space flight experiments. The results of this study show that the beam facility is capable of producing a directional beam of neutral atomic oxygen atoms with the needed flux and energy to simulate low Earth orbit (LEO) conditions for real time accelerated testing. The flux distribution in this facility is uniform to +/- 6 percent of the peak flux over a beam diameter of 6 cm. Author

**N91-20737*#** Nebraska Univ., Lincoln. Center for Microelectronic and Optical Materials Research.
**GROUND AND SPACE BASED OPTICAL ANALYSIS OF MATERIALS DEGRADATION IN LOW-EARTH-ORBIT** **c25**
John A. Woollam, Ron Synowicki, Jeffrey S. Hale, Jane Peterkin, Hassanayn Machlab, Bhola N. De, and Blaine Johs *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 772-777 (For primary document see N91-20702 12-59)
(Grant NAG3-95)
Avail: NTIS HC/MF A14 CSCL 07D

There is strong interest in being able to accurately and sensitively monitor materials degradation in both ground-based and space-based environments. Two optical techniques for sensitive degradation monitoring are reviewed: spectroscopic ellipsometry and photothermal spectroscopy. These techniques complement each other in that ellipsometry is sensitive to atomically thin surface and subsurface changes, and photothermal spectroscopy is sensitive to local defects, pin-holes, subsurface defects, and delamination. Progress in applying these spectroscopies (both ex situ and in situ) to atomic oxygen degradation of space materials is reviewed. Author

**N91-20738*#** Case Western Reserve Univ., Cleveland, OH. Center for the Commercial Development of Space.
**THE TRANSITION OF GROUND-BASED SPACE ENVIRONMENTAL EFFECTS TESTING TO THE SPACE ENVIRONMENT** **c25**
Stephen V. Zaat, Glen A. Schaefer, and John F. Wallace *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 778-784 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 07D

The goal of the space flight program at the Center for Commercial Development of Space (CCDS)--Materials for Space Structures is to provide environmentally stable structural materials to support the continued humanization and commercialization of the space frontier. Information on environmental stability will be obtained through space exposure, evaluation, documentation, and subsequent return to the supplier of the candidate material for internal investigation. This program provides engineering and scientific service to space systems development firms and also exposes CCDS development candidate materials to space environments representative of in-flight conditions. The maintenance of a technological edge in space for NASA suggests the immediate search for space materials that maintain their structural integrity and remain environmentally stable. The materials being considered for long-lived space structures are complex, high strength/weight ratio composites. In order for these new candidate materials to qualify for use in space structures, they must undergo strenuous testing to determine their reliability and stability when subjected to the space environment. Ultraviolet radiation, atomic oxygen, debris/micrometeoroids, charged particles radiation, and thermal fatigue all influence the design of space structural materials. The investigation of these environmental interactions is the key purpose of this center. Some of the topics discussed with respect to the above information include: the Space Transportation System, mission planning, spaceborne experiments, and space flight payloads. Author

**N91-20739*#** Institute for Computer Applications in Science and Engineering, Hampton, VA.
**CUMULATIVE REPORTS AND PUBLICATIONS THROUGH DECEMBER 31, 1990 Final Report**
Feb. 1991 77 p
(Contracts NAS1-18605; NAS1-18107; NAS1-17070; NAS1-17130; NAS1-15810; NAS1-16394; NAS1-14101; NAS1-14472)
(NASA-CR-187506; NAS 1.26:187506) Avail: NTIS HC/MF A05 CSCL 12A

This document contains a complete list of ICASE reports. Since ICASE reports are intended to be preprints of articles that will appear in journals or conference proceedings, the published reference is included when it is available. Author

# 60 COMPUTER OPERATIONS AND HARDWARE

Includes hardware for computer graphics, firmware, and data processing.

For components see *33 Electronics and Electrical Engineering.*

**N91-20740#** David Sarnoff Research Center, Princeton, NJ.
**HIGH PERFORMANCE VIDEO COMPUTER Quarterly Technical Report No. 1, 1 Feb. - 15 Oct. 1990**
S. P. Knight 5 Nov. 1990 7 p
(Contract MDA972-90-C-0022)
(AD-A229884) Avail: NTIS HC/MF A02 CSCL 12/5

A continuous, real time video system simulation capability is examined. The simulation of video is real time in a computationally intense problem. In the case of the NTSC video standard, a complete receiver function would require about 560 Giga-operations/s for real time performance in which an operation is defined as a single bit operation. In the case of the newly

proposed HDTV standards, the computational needs are enormous-growing to over 60 Tera-operations/s. In addition, the I/O system of such a computer must be able to sustain a data rate of at least 380 Mbytes/s. The David Sarnoff Research Center has developed a massively parallel computer technology known as the Princeton Engine, which can meet the computational requirements noted above for the NTSC video standard. GRA

**N91-20741#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
**INITIALIZATION FOR IMPROVED IIR FILTER PERFORMANCE**
E. S. Chornoboy 31 Dec. 1990 21 p
(Contract DTFA01-L-83-4-10579)
(AD-A230061; TR-828; DOT/FAA/NR-90/7) Avail: NTIS HC/MF A03 CSCL 17/9

A new method for initializing the memory registers of Infinite Impulse Response (IIR) filters is presented. This method is shown to significantly reduce the initial transients which accompany the filtering of finite-length data sequences. Unlike previous methods, the proposed method makes no a priori assumptions regarding the input signal. Therefore, the method applies equally well to a variety of IIR designs and applications. The method does require a leading segment of the input data for initialization computations before filtering can begin. For this reason, the method is best suited for signal-processing applications in which batch processing of the data is employed. In particular, the method could prove very useful in situations where data is at a premium and only short-length sequences are available, because almost all data is usable after filtering. Applications using sequential processing of data can be accommodated when delays at the beginning of a processing segment can be tolerated. GRA

**N91-20742#** Defence Research Establishment, Ottawa (Ontario).
**MICRO-RADIOGRAPHY USING AN ELECTRON LINAC SOURCE AND RAM MEMORY CHIP DETECTORS**
T. Cousins, E. L. Karam, and J. R. Brisson Jun. 1990 32 p
(AD-A229658; DREO-TN-90-16) Avail: NTIS HC/MF A03 CSCL 20/7

Radiography using a pulsed electron (LINAC) source and a semiconductor memory chip (SRAM) as a detector has been investigated. The responses of commercial SRAMS and Dynamic Random Access Memory (DRAM) were examined, with the SRAM proving superior for radiography. A variety of shapes (circular holes, slits, etc.) were radiographed with the results being encouraging for future work. GRA

**N91-20743#** Naval Research Lab., Washington, DC.
**BENCHMARKING THE CONNECTION MACHINE Final Report**
Michael A. Young 21 Nov. 1990 24 p
(AD-A229705; NRL-9289) Avail: NTIS HC/MF A03 CSCL 12/5

Performance of various computers is compared by running programs across different machines and comparing execution times (benchmarking the computers). Scientific or engineering benchmarks are usually measured in Mflops (millions of floating point operations per second). The current state of benchmarking supercomputer architectures is not very clear. Performances of a specific supercomputer on various benchmarks may vary greatly, making the judgment extremely difficult. Naturally, certain benchmarks may be more suited to a particular machine's architecture. Running standard benchmarks, without modification, across various supercomputers can show the effectiveness of the compilers in using the available resources. This allows comparison with an optimized code implementation. This paper presents the results of benchmarking the Connection Machine CM-2 a (a parallel processor) with an efficient, highly parallel implementation of the Livermore Loops. Re-coded in CM Fortran, only a few of the kernels required significant modification. The loops have been one of the most often run benchmark suites and form a good testbed for parallel machines due to the many varied computational structures. Analysis and discussion of the single and double precision Mflop rates are presented for large vector lengths on a 32 K CM-2. For applications involving large vector lengths, a large amount of computation, and minimal general communication the CM-2 performs extremely well. GRA

**N91-20744#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**AUTOMATIC DETERMINATION OF RECOMMENDED TEST COMBINATIONS FOR Ada COMPILERS M.S. Thesis**
James S. Marr Dec. 1990 221 p
(AD-A230461; AFIT/GCS/ENG/90D-09) Avail: NTIS HC/MF A10 CSCL 12/5

Ada compilers are validated using the Ada Compiler Validation Capability (ACVC) test suit, containing over 4000 individual test programs. Each test program focuses, to the extent possible, on a single language feature. Despite the advantages of this atomic testing methodology, it is often the unexpected interactions between language features that result in compilation problems. This research investigated techniques to automatically identify recommended combinations of Ada language features for compiler testing. A prototype program was developed to analyze the Ada language grammar specification and generate a list of recommended features to be tested. The output from this program will be used within the Ada Features Identification System (AFIS), a configuration management tool for the ACVC test suite. AFIS is being developed by the ACVC Maintenance Organization (AMO). The prototype uses annotated Ada language grammar to drive a test case generator. The generated combinations of Ada features are analyzed to select the combinations to be tested. While the skill and intuition of the compiler tester are essential to the annotation of the Ada grammar, the prototype demonstrated that automated support tools can be used to identify recommended combinations for Ada compiler testing. GRA

**N91-20745#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**A COMPACT OPTICAL ASSOCIATIVE MEMORY USING DYNAMIC HOLOGRAPHIC STORAGE MEDIA AND PHOTOREFRACTIVE GAIN AND ATTENUATION ELEMENTS M.S. Thesis**
Thomas J. Burns Dec. 1990 185 p
(AD-A230661; AFIT/GEO/ENG/90D-02) Avail: NTIS HC/MF A09 CSCL 20/6

This research effort implemented a compact optical associative memory architecture consisting of a Fabry-Perot Confocal Resonator (FPCR) optical processing environment, two dynamically reprogrammable Lithium Niobate volume holograms, and Barium Titanate gain and attenuation elements. The reduced physical dimensions of the compact optical processing environment make it more adaptable to military applications than previous associative memory designs. The FPCR employs Mangin mirrors designed to reduce spherical aberrations in off-axis rays. The orientation of the gain element's grating vector angle and the model used to predict the profile of the attenuation element were unique to this research effort. The object stored in the associative memory was phase encoded using a glass microscope slide etched in a 40 percent hydrofluoric acid solution. Beam path deviations caused by the non-parallel geometry of the photorefractive crystals were corrected with a variable pitch, plate glass optical wedge inserted in the cavity's feedback arm. Experimental results showed the system is capable of storing and fully retrieving a single object from memory when presented with partial information about the object Additional system modifications are required to store and retrieve multiple objects. GRA

**N91-20716*#** Lockheed Engineering and Sciences Co., Houston, TX.
**THE USE OF ANALYTICAL MODELS IN HUMAN-COMPUTER INTERFACE DESIGN**
Leo Gugerty *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 574-581 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 09B

**N91-20718*#** Lockheed Engineering and Sciences Co., Houston, TX.
**DEVELOPING THE HUMAN-COMPUTER INTERFACE FOR SPACE STATION FREEDOM**
Kritina L. Holden *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 588-594 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 09B

# 61 COMPUTER PROGRAMMING AND SOFTWARE

Includes computer programs, routines, alogorithms, and specific applications, e.g., CAD/CAM.

**N91-20746#** National Inst. of Standards and Technology, Gaithersburg, MD. Robot Systems Div.
**A CLOSED-FORM MASSIVELY-PARALLEL RANGE-FROM-IMAGE-FLOW ALGORITHM**
Daniel Raviv (Florida Atlantic Univ., Boca Raton.) and James S. Albus Oct. 1990 15 p
(PB91-112805; NISTIR-4450) Avail: NTIS HC/MF A03 CSCL 09B

A closed-form solution for obtaining the three-dimensional structure of a scene for a given six degree of freedom motion of a camera is provided. The solution is massively parallel, i.e., the range that corresponds to each pixel is dependent on the spatial and temporal changes in intensities of that pixel and on the motion parameters of the camera. The measurements of the intensities are done in a priori known directions. The solution is for the general case of camera motion. The derivation is based upon representing the image in the spherical coordinate system, although a similar approach could be taken for other image domains, e.g., the planar coordinate system. The amount of computations, errors, and singular points of the solutions are discussed, and a practical way to significantly reduce and implement them is suggested. GRA

**N91-20747#** Defence Research Establishment Atlantic, Dartmouth (Nova Scotia).
**EXAMPLES MANUAL FOR PROGRAM MAVART**
G. W. McMahon and E. L. Skiba (Acres Consulting Services, Niagara Falls, Ontario ) Aug. 1990 101 p
(AD-A229104; DREA-TM-90/204) Avail: NTIS HC/MF A06 CSCL 12/5

MAVART is a two-dimensional, dynamic finite-element code. It was developed primarily for analysis of axisymmetric electroacoustic transducers, and the name is an acronym for the code's function, that is, a Model to Analyze the Vibrations and Acoustic Radiation of Transducers. It was first implemented in 1976, under a contract with Acres Consulting Services, Niagara Falls, Ontario. It has been revised and improved a number of times over the years, the latest version (MAVART9 - 1989) resulting from a contract with Ortech International, Mississauga. The main revision introduced in MAVART9 is the installation of the Waterloo University's SPARSPAK solver package, replacing the profile solver used in the previous version. Other new features are the addition of torsional analysis capability and the ability to conduct a resonance search on any specified degree-of-freedom. GRA

**N91-20748*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**EFFICIENT COMPUTATION OF AERODYNAMIC INFLUENCE COEFFICIENTS FOR AEROELASTIC ANALYSIS ON A TRANSPUTER NETWORK**
David C. Janetzke and Durbha V. Murthy (Toledo Univ., OH.) 1991 32 p Presented at the Symposium on Parallel Methods on Large-Scale Structural Analysis and Physics Applications, Hampton, VA, 5-6 Feb. 1991; sponsored by NASA. Langley and AFWL
(NASA-TM-103671; E-5883; NAS 1.15:103671) Avail: NTIS HC/MF A03 CSCL 09B

Aeroelastic analysis is multi-disciplinary and computationally expensive. Hence, it can greatly benefit from parallel processing. As part of an effort to develop an aeroelastic capability on a distributed memory transputer network, a parallel algorithm for the computation of aerodynamic influence coefficients is implemented on a network of 32 transputers. The aerodynamic influence coefficients are calculated using a 3-D unsteady aerodynamic model and a parallel discretization. Efficiencies up to 85 percent were demonstrated using 32 processors. The effect of subtask ordering, problem size, and network topology are presented. A comparison to results on a shared memory computer indicates that higher speedup is achieved on the distributed memory system. Author

**N91-20749#** Japan Atomic Energy Research Inst., Tokyo.
**COMPUTER CODE CONVERSION USING HISTORIAN**
Kiyoshi Matsumoto and Toshimasa Kumakura Sep. 1990 90 p In JAPANESE; ENGLISH summary
(DE91-744830; JAERI-M-90-146) Avail: NTIS HC/MF A05

When a computer program written for a computer A is converted for a computer B, in general, the A version source program is rewritten for B version. However, in this way of program conversion, the following inconvenient problems arise: (1) the original statements to be rewritten for B version are lost; (2) if the original statements of the A version rewritten for B version would remain as comment lines, the B version source program becomes quite large; and (3) when update directives of the program are mailed from the organization which developed the program or when some modifications are needed for the program, it is difficult to point out the part to be updated or modified in the B version source program. To solve these problems, the conversion method using the general-purpose software management aid system, HISTORIAN, has been introduced. This conversion method makes a large computer code an easy-to-use program for us to update, modify, or improve after the conversion. This report describes the planning and procedures of the conversion method and the MELPROG-PWR/MOD1 code conversion from the CRAY version to the JAERI FACOM version as an example. DOE

**N91-20750** Tel-Aviv Univ. (Israel). Dept. of Computer Science.
**A PRIMAL DUAL PATH FOLLOWING ALGORITHM FOR LINEAR PROGRAMMING WITH BOX TYPE CONSTRAINTS M.S. Thesis**
Haim Kaplan Aug. 1989 44 p
(ITN-91-85087) Copyright Avail: Tel-Aviv Univ., Exact Sciences Library, Ramat Aviv 69978, Israel

We describe a primal-dual interior path-following algorithm which solves programming problems in which the variables have both upper and lower bounds. The complexity of the algorithm is O(m(n exp 1.5)L + (m exp 2)nL), where n is the number of variables, m is the number of equality constraint and L is the problem size. The algorithm is based on Monteiro and Adler's algorithm, which handles problems in standard form, i.e., with lower (nonnegativity) bounded variable only. Our algorithm has the same complexity as the latter. This improves upon the O((n exp 3)L) complexity which is achievable by applying the Monteiro-Adler algorithm on upper bounded problems transformed to standard form. Author (ISA)

**N91-20751** Tel-Aviv Univ. (Israel). Dept. of Computer Science.
**A SOURCE-TO-SOURCE TRANSLATOR GENERATOR AND ITS IMPLEMENTATION FOR ROBOTIC LANGUAGES M.S. Thesis**
Amnon Lotem Mar. 1989 118 p
(ITN-91-85089) Copyright Avail: Tel-Aviv Univ., Exact Sciences Library, Ramat Aviv 69978, Israel

The main interest was in the development of source-to-source translators between high-level programming languages, when more than one language is involved. Such is the case for conversion of a general robotic simulation language into specific languages for industrial robots, or for writing translators from well established programming languages into a new language, which becomes the

standard. The latter applies to translators for Ada. Previous works concentrated on ways to define the relations between the input and output languages in terms which are specific for these languages. However, the use of direct and specific transformations for language conversion makes the reuse of these transformations in other translators impossible. The concept behind the current work is that specific transformations can be constructed of a limited number of basic transformations, which can be employed in developing more than one translator. Each translator involves the definition of the transition from the input language into an intermediate language, M, and from M into the output language. Sublanguages, MI and MO, of M correspond to the input and output languages, respectively. A catalogue of basic transformation rules, relating to M, provides a basis for many translators. A translator generator system (T-GEN) was developed to create the specific set of MI-to-MO translation instructions automatically, on the basis of the catalogue. The input of T-GEN comprises the description of M, the specifications of MI and MO, and a catalogue of transformation rules. T-GEN was implemented, with emphasis on robotic language and neglecting some of the problems involved in translation between ordinary procedural languages. However, the underlying concept of the work and its implementation methods appear to be general. ISA

**N91-20752** Tel-Aviv Univ. (Israel). Dept. of Computer Science.
**AN APPLICATION GENERATOR (AG) FOR A FAMILY OF REAL-TIME MONITOR AND CONTROL SYSTEMS (RTMCS) M.S. Thesis**
Tamar Benaya Sep. 1989 81 p
(ITN-91-85090) Copyright Avail: Tel-Aviv Univ., Exact Sciences Library, Ramat Aviv 69978, Israel

This thesis presents an application generator (AG) for a family of real-time monitor and control systems (RTMCS). The input to the AG is a system specification of a desired RTMCS and the output is an Ada program for the specified system (the target system). The main steps in the process of generating such systems are: (1) system specification - a system specification of a desired RTMC system is defined, with the aid of an interactive, menu-driven program; (1) system validation - the system specification is checked for internal inconsistencies and omissions; (3) code generation - Ada code is generated for the specified target system; and (4) operation/simulation of the target system - the generated code is compiled and linked to produce either an operational target system or a simulation of a target system. The family of applications for which this AG was developed includes real-time systems which receive data from the real world, based on asynchronous interrupts. They process the data by performing transformation, analysis and timed response in the form of local displays, alarms and remote control, and control the environment by means of both operator and automatic control. Author (ISA)

**N91-20753#** Netrologic, Inc., San Diego, CA.
**FRACTAL IMAGE ENCODING Final Report**
Yuval Fisher and Albert Lawrence 17 Nov. 1990 35 p
Sponsored by ONR
(AD-A229910) Avail: NTIS HC/MF A03 CSCL 12/9

The coding, storage, and reconstruction of images is a major concern in the application of computer technology to technical and scientific problems. One example is the flood of geophysical and intelligence data originating from satellite platforms. In such applications it is highly desirable to reduce the storage and transmission requirements for image data. An image can be coded compactly when it is possible to exploit self similar redundancy in the image. The development of such a so-called fractal method for compressing image data has been the focus of the research project. Fractal compression is a promising approach to image compression. Within a very short development time, fractal techniques have yielded results which rival the best examples of data compression afforded by other methods. Although fractal encoding of images is complex and may require specialized hardware for real time applications, the decoding process can be widely utilized because it is simple, fast, and suitable for software implementation. Thus, it can be run on workstations or personal computers without special requirements. GRA

**N91-20754#** Army Natick Labs., MA.
**A COMPUTER PROGRAM FOR MEASURING FIBERS WITH THE ZEISS CSM 950 SCANNING ELECTRON MICROSCOPE Final Report, Jul. - Sep. 1990**
Deborah Sakelakos and Samuel H. Cohen Nov. 1990 28 p
(AD-A229952; NATICK/TR-91/004) Avail: NTIS HC/MF A03 CSCL 12/5

A computer program designed for the stereological measurement of fibers was written for use with a ZEISS CSM 950 scanning electron microscope (SEM). This program utilized the ZEISS' build-in kontron image analyzer to access measurements of a variety of parameters for fiber analysis of images from a video camera, light microscope, or SEM. The program was written to permit interaction between the menu program displayed on the TV monitor and the keyboard or mouse. This increased capability permits the operator to change parameters within the measurement program depending on the type of fiber sample. Since research presently being conducted in these laboratories on ballistic fibers, including biotechnologically derived fibers, requires information about fiber size, shape, etc., developing a menu-oriented computer program facilitates that purpose. GRA

**N91-20755#** Ballistic Research Labs., Aberdeen Proving Ground, MD.
**A LOGICAL FRAMEWORK FOR DISTRIBUTED DATA Final Report, 1 Sep. 1989 - 31 Aug. 1990**
Paul Broome and Barbara Broome Nov. 1990 26 p
(AD-A230037; BRL-MR-3882) Avail: NTIS HC/MF A03 CSCL 12/7

In this paper we consider logic programming as a means of both computing and formulating complex queries in the same system and describe the application of these concepts to a medium sized database. In particular, we establish a term representation of the data used in an experimental battlefield information system and conceptually extend this database with rules. We develop browsing operations for that system by combining logical operations with constraints. These programs and queries have mathematical properties that can be specified as equations between relations. We than apply these equations to support program transformations that improve query efficiency. This work increases the likelihood of performing declarative operations on the constantly changing data associated with distributed databases. GRA

**N91-20756#** Massachusetts Inst. of Tech., Cambridge.
**AN INCREMENTAL TYPE INFERENCE SYSTEM FOR THE PROGRAMMING LANGUAGE Id**
Shail A. Gupta Nov. 1990 176 p
(Contract N00014-84-K-0099)
(AD-A230085; MIT/LCS/TR-488) Avail: NTIS HC/MF A09 CSCL 12/5

Modern computing environments strive to be robust and reliable, and at the same time, aim at providing enough flexibility to an interactive user to edit, debug, and test programs easily and efficiently. Strongly typed languages satisfactorily meet the former goal by guaranteeing that type-consistent programs will not incur run-time type-errors. But most programming environments for such languages have to sacrifice the flexibility of interactive and incremental program development in order to achieve this consistency over the whole program. The problem is further complicated by the presence of polymorphism in many of these languages, where the definition of type-consistency is one of inclusion, rather than equality. Author (GRA)

**N91-20757#** Arnold Engineering Development Center, Arnold Air Force Station, TN.
**INTERACTIVE EAGLE: AN INTERACTIVE SURFACE MESH AND THREE-DIMENSIONAL GRID GENERATION SYSTEM. VERSION 1.0 USER'S GUIDE Final Report, 1 Oct. 1988 - 30 Jun. 1990**

W. E. Dietz and S. B. Evans Dec. 1990 171 p
(AD-A230093; AEDC-TR-90-25) Avail: NTIS HC/MF A08
CSCL 12/1

The generation of surfaces and three-dimensional grids for use in finite-difference computations is tedious and time-consuming, but can be made more efficient when implemented in a workstation-based interactive environment. Interactive EAGLE is an interactive surface mesh and three-dimensional grid generation system based on the wellknown EAGLE grid generation codes. Interactive EAGLE implements most of the functions available in the batch EAGLE codes and has been extended to allow input in the form of cross-sectional profiles. Interactive EAGLE performs all input functions through interactive screens and menus, and significantly increases the rate at which surface meshes and three-dimensional grids can be generated. In addition, the user can access the wide range of powerful operations available in the EAGLE codes without knowledge of the input requirements and internal structure of the batch versions. GRA

**N91-20758#** Massachusetts Inst. of Tech., Cambridge. Lab. for Computer Science.
**ON-LINE ALGORITHMS FOR 2-COLORING HYPERGRAPHS VIA CHIP GAMES**
Javed A. Aslam and Aditi Dhagat Dec. 1990 18 p
(Contract N00014-87-K-825)
(AD-A230200; MIT/LCS/TM-439) Avail: NTIS HC/MF A03
CSCL 12/2

The problem of 2-coloring hypergraphs is known to be NP-complete. However, for k-hypergraphs Eta of degree k, and k greater than or equal to 10, the Lovasz Local Lemma guarantees the existence of a 2-coloring of Eta such that no edge is monochromatic. We present an on-line algorithm to find such a coloring for k-hypergraph with fewer than 2(exp k-1) edges. The algorithm also works for k-hypergraphs with no degree constraints and is easily generalized to an algorithm for d-coloring a k-hypergraph with fewer than d(exp k-1) edges. The algorithms are Omicron(1)-competitive against adaptive on-line adversaries. Further, we show that for k-hypergraphs with greater than or equal to 4(exp k) edges, there exists a simple on-line adversary which thwarts any on-line 2-coloring algorithm. This adversary generalizes to work against on-line algorithms attempting to d-color k-hypergraphs with greater than or equal to 2(exp dk) edges. A cleverer on-line adversary is also shown which succeeds against on-line algorithms attempting to 2-color k-hypergraphs with greater than or equal to k(1 + phi)(exp k) edges (where phi is the Golden Ratio). Another on-line adversary is shown which succeeds against on-line 2-coloring algorithms for degree k k-hypergraphs with greater than or equal to (3 + 2 square root of 2)(exp k) edges. All of these results are achieved using a Chip Game model. We show that on-line algorithms for a scheduling problem follow from these 2-coloring algorithms. GRA

**N91-20759#** Dayton Univ., OH.
**COMPUTER MENU TASK PERFORMANCE MODEL DEVELOPMENT Final Report, Sep. 1987 - Feb. 1990**
Byron J. Pierce, Stanley R. Parkinson, and Norwood Sisson Nov. 1990 81 p
(Contract F33615-90-C-0005)
(AD-A230278; AFHRL-TR-90-26) Avail: NTIS HC/MF A05
CSCL 12/5

This report provides a review of literature on computer menu interface design and related performance factors. Implications for the design of the user/system interface for aircraft simulator instructional support systems are considered. A criterion-based search model that makes predictions as to how the number of alternatives on menu pages affects the search process and the pattern of errors that will result is evaluated. The literature on theoretical and empirical work suggests two additional factors that are recommended for inclusion into the search model: (1) user-perceived relationships among target items sought and menu alternatives available for selection, and (2) the probability of an omission situation where the target items is not subsumed under any of the alternatives available for selection. An experiment was conducted to test the effect that all three of these factors have on menu task performance. Results showed that all three factors significantly influenced menu search and response accuracy. A two-criterion menu model was proposed as a means to explicate the performance results of the menu experiment. GRA

**N91-20760#** Naval Postgraduate School, Monterey, CA. Dept. of Administrative Sciences.
**VALIDATING SOFTWARE METRICS Technical Report, Dec. 1989 - Sep. 1990**
Norman F. Schneidewind 30 Sep. 1990 33 p
(Contract N00030-90-WR-02112AA)
(AD-A230309; NPS-AS-90-019; NPS54-90-019) Avail: NTIS HC/MF A03 CSCL 12/5

We propose a comprehensive metrics validation methodology that has six validation criteria, each of which supports certain quality functions. New criteria are defined and illustrated, including consistency, discriminative power, tracking and repeatability. We show that non-parametric statistical methods play an important role in evaluating metrics against the validity criteria. A detailed example of the application of methodology is presented. GRA

**N91-20761#** Stanford Univ., CA. Systems Optimization Lab.
**TWO CHARACTERIZATIONS OF SUFFICIENT MATRICES**
Richard W. Cottle and Sy-Ming Guu Dec. 1990 11 p
(Contracts N00014-89-J-1659; DE-FG03-87ER-25028)
(AD-A230319; SU-SOL-90-17) Avail: NTIS HC/MF A03 CSCL 12/4

Two characterizations are given for the class of sufficient matrices defined by Cottle, Pang and Venkateswaran. The first is a direct translation of the definition into linear programming terms. The second can be thought of as a generalization of a theorem of T.D. Parsons on P-matrices. GRA

**N91-20762#** Naval Ocean Systems Center, San Diego, CA.
**SYSTOLIC SIGNAL PROCESSOR/HIGH FREQUENCY DIRECTION FINDING Final Test Report, FY 1989 - FY 1990**
J. P. Loughlin and F. M. Tirpak, Jr. Oct. 1990 26 p
(AD-A229706; NOSC/TR-1369) Avail: NTIS HC/MF A03
CSCL 12/6

This report documents the feasibility of hosting computationally intensive signal processing algorithms on a systolic array architecture. The practicality of such hosting is demonstrated through use of the High Speed Systolic Array Processor (HiSSAP) testbed and a high frequency direction finding algorithm. Systolic architectures provide a viable alternative to using traditional computer hosts for signal processing application requiring massive quantities of matrix-based computational throughput. The systolic implementations of a four-channel finite impulse responses (FIR) filter and multiple signal classification (MUSIC) direction of arrival estimator yielded results consistent with theoretical models. The tests conducted on the HiSSAP testbed demonstrated the feasibility of experimental data produced by both an analytical model and an antenna simulator within a controlled laboratory signal environment. The scope of this investigation should be expanded to include processing of actual off-the-air high frequency radio signals. This advanced level of testing can more realistically estimate the essential design specifications for a proper systolic host for adaptive signal processing algorithms. GRA

**N91-20763#** Naval Research Lab., Washington, DC.
**ENHANCING MULTIDIMENSIONAL TREE STRUCTURES BY USING A BILINEAR DECOMPOSITION**
Jeffrey K. Uhlmann 19 Nov. 1990 11 p
(AD-A229756; NRL-9282) Avail: NTIS HC/MF A03 CSCL 17/11

The k-d tree data structure provides a relatively distribution-independent means for satisfying orthogonal range queries on k-dimensional objects in average case time. This time is proportional to the theoretic optimum for any data structure whose storage requirements scale linearly. Given this optimality, much work in the area of distribution-independent near-neighbor algorithms has been directed towards enhancing the k-d tree and

its associated search techniques to reduce its search time proportionality constant. This report suggests an enhancement that furthers this end. Important applications include data correlation problems associated with multitarget tracking. In particular, techniques described in this report have been incorporated into the TRC and Real tracking and correlation systems. A k-d tree is a binary in which the set of k-dimensional points may be partitioned at each node according to any of the k coordinates. The discriminating coordinate for each node can be selected to prevent anisotropy in the distribution. This is accomplished by recursively partitioning the set according to the median data point of the projection of the data onto the coordinate axis that has the greatest dispersion. Thus, a node will contain (either implicity or explicity) identification of the discriminating coordinate and pointers to the set of points whose values for the discriminating coordinate are greater than that of the median and to the set of points whose values are less than the median. GRA

**N91-20764#** Massachusetts Inst. of Tech., Cambridge. Lab. for Computer Science.

**BOUNDS ON THE TIME TO REACH AGREEMENT IN THE PRESENCE OF TIMING UNCERTAINTY**

Hagit Attiya, Cynthia Dwork, Nancy Lynch, and Larry Stockmeyer Nov. 1990 45 p

(Contracts N00014-89-J-1988; N00014-87-K-0825)

(AD-A229766; MIT/LCS/TM-435) Avail: NTIS HC/MF A03 CSCL 12/4

Upper and lower bounds are proved for the time complexity of the problem of reaching agreement in a distributed network, in the presence of process failures and inexact information about time. It is assumed that the amount of (real) time between any two consecutive steps of any nonfaulty process is at least c(sub 1) and at most c(sub 2); thus, C = c(sub 1)/c(sub 2) is a measure of the timing uncertainty. It is also assumed that the time for message delivery is at most d. Processes are assumed to fail by stopping, so that process failures can be detected by timeouts. A straightforward adaption of an (f + 1)-round round-based agreement algorithm takes time (f + 1)Cd if there are function faults, while a straightforward reduction from a timing-based algorithm to a round-based algorithm yields a lower bound of (f + 1)d. The first major results major result of this paper is an agreement algorithm in which the uncertainty factor C is only incurred for one round, yielding a running time of approximately 2fd + Cd in the worst case. The second major result shows that any agreement algorithm must take time at least (f - 1)d + Cd in the worst case. The new agreement algorithm can also be applied in a model where processors are synchronous (C = 1), and where message delay during a particular execution of the algorithm is bounded above by a quantity delta which could be smaller than the worst-case upper bound d. GRA

**N91-20765*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**ALPS: A LINEAR PROGRAM SOLVER**

Donald C. Ferencz (Case Western Reserve Univ., Cleveland, OH.) and Larry A. Viterna Apr. 1991 92 p

(NASA-TM-104347; E-6122; NAS 1.15:104347) Avail: NTIS HC/MF A05 CSCL 09B

ALPS is a computer program which can be used to solve general linear program (optimization) problems. ALPS was designed for those who have minimal linear programming (LP) knowledge and features a menu-driven scheme to guide the user through the process of creating and solving LP formulations. Once created, the problems can be edited and stored in standard DOS ASCII files to provide portability to various word processors or even other linear programming packages. Unlike many math-oriented LP solvers, ALPS contains an LP parser that reads through the LP formulation and reports several types of errors to the user. ALPS provides a large amount of solution data which is often useful in problem solving. In addition to pure linear programs, ALPS can solve for integer, mixed integer, and binary type problems. Pure linear programs are solved with the revised simplex method. Integer or mixed integer programs are solved initially with the revised simplex, and the completed using the branch-and-bound technique. Binary programs are solved with the method of implicit enumeration. This manual describes how to use ALPS to create, edit, and solve linear programming problems. Instructions for installing ALPS on a PC compatible computer are included in the appendices along with a general introduction to linear programming. A programmers guide is also included for assistance in modifying and maintaining the program. Author

**N91-20766#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**THE DEVELOPMENT OF A GRAPHICAL NOTATION FOR THE FORMAL SPECIFICATION OF SOFTWARE M.S. Thesis**

Gene A. Place Dec. 1990 260 p

(AD-A230458; AFIT/GCS/ENG/90D-10) Avail: NTIS HC/MF A12 CSCL 12/5

The program transformations lifecycle model, proposed by Balzer in 1984, may hold the key to a dramatic leap in software engineer productivity necessitated by the tremendous growth in the world's demand for software. This leap in productivity is made possible by the program transformation lifecycle's reliance on formal specifications rather than programs as the primary vehicle for the creation and maintenance of software systems. Because formal specifications are concerned only with system behaviors and not implementation details, formal specifications tend to present critical system characteristics much more concisely than programs. The major disadvantage of using formal specifications in a software development process, however, is that, because of their highly mathematical nature, formal specifications tend to be very difficult to create, understand, and maintain for the average software engineer or programmer. This thesis develops a graphical formal specification language based on the Refine wide spectrum language using a graph based iconic representation to present formal specifications in a format that is much easier to create and manipulate than the equivalent textual formal specifications. GRA

**N91-20767#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**MAPPING AN OBJECT-ORIENTED REQUIREMENTS ANALYSIS TO A DESIGN ARCHITECTURE THAT SUPPORTS DESIGN AND COMPONENT REUSE M.S. Thesis**

Kelly L. Spicer Dec. 1990 213 p

(AD-A230460; AFIT/GCS/ENG/90D-13) Avail: NTIS HC/MF A10 CSCL 12/5

Design reuse has more potential for increasing the productivity of software development and maintenance than do traditional approaches to software reuse that emphasize reuse of smaller components. Current software development methods do not promote design reuse. The literature contains limited documented research on the subject, but enough that some design reuse principles can be gleaned. Among these principles are that reusable designs should be applicable within some domain of application, have a consistent structure, provide a method for instantiating the design, avoid object nesting, and promote reuse of smaller components as well. A design mapping method from an object-oriented requirements analysis to a design that follows the principles of design reuse is presented in this thesis. The mapping method involves two transformation steps and introduces four representation tools for conducting the transformations. These tools are the Object-Mapping Table; the Hierarchical-Structure Diagram, which represents the static structure of the design; the Event-Mapping List; and the Object-Event Interconnection Diagram, a graphical representation of the Event-Mapping list to show the design dynamics. The second step transforms these representations into Ada specifications. Design templates are developed to aid in this transformation. The design method is applied to two problems to demonstrate the consistent designs it produces. The first problem is then carried through to completion. GRA

**N91-20768#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**A HYPERMEDIA IMPLEMENTATION FOR REUSABLE SOFTWARE COMPONENT REPRESENTATION M.S. Thesis**
Gary G. Worrall Dec. 1990 97 p
(AD-A230497; AFIT/GCS/ENG/90D-16) Avail: NTIS HC/MF A05 CSCL 05/2

This study investigated software component representation methods. Hypermedia was chosen as the implementation method to represent a collection of reusable software components. The hypermedia implementation organizes knowledge about the component collection into a web of small information chunks called frames. The set of software components was represented using a hybrid classification scheme composed of enumerated and faceted parts. The enumerated part enables the user to progress along a path in a taxonomic tree, narrowing the scope of eligible components. Each leaf node in this tree denotes a class of components, members of which are distinguished by their time and space characteristics. These characteristics, known as forms, are grouped into eleven facets, each comprised of two to four elements. Links between frames establish a means of traversing the information net. Some of these links allow the user to progress directly through the levels of the classification structure. Other links lead from the classification structure frames containing explanatory text for the terms used in the classification. Additional links cross-reference related topics. GRA

**N91-20769#** Honeywell, Inc., Minneapolis, MN. Systems and Research Center.
**KBSA FRAMEWORK Final Report, Mar. 1988 - Apr. 1990**
Aaron Larson, Jeff Clark, John Kimball, and Bob Schrag Dec. 1990 129 p
(Contract F30602-86-C-0074)
(AD-A230621; RADC-TR-90-349) Avail: NTIS HC/MF A07 CSCL 12/5

Research is described which was performed while developing specifications for a support environment (framework) suitable for serving as the common basis for integration and continued development of the many lifecycle facets of the Knowledge-Based Software Assistant (KBSA). The KBSA will be a system which provides significant automation in the development and lifetime support of large software systems. A history of the effort including a background for many of the design decisions and the lessons learned throughout the project are included. GRA

**N91-20770#** Aeronautical Research Labs., Melbourne (Australia).
**A FORTRAN PROGRAM FOR PROCESSING LOW SPEED WIND TUNNEL TEST DATA FOR THE JINDIVIK AUXILIARY INTAKE**
Y. Y. Link Sep. 1990 37 p
(AD-A230726; ARL-FLIGHT-MECH-TM-426; DODA-AR-005-584) Avail: NTIS HC/MF A03 CSCL 12/5

A FORTRAN computer program was written for post processing low speed wind tunnel pressure data acquired from the Jindivik auxiliary intake model. The scanivalve pressure measurement system was used with the standard data acquisition system to read the pressures from 59 pressure tappings. The program analyzed raw data and produced numerical and graphical output. These consisted of static pressure graphs, mass flow graphs, and total pressure contour plots. GRA

**N91-20771#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**FEASIBILITY ANALYSIS OF DEVELOPING A FORMAL PERFORMANCE MODEL OF Ada TASKING M.S. Thesis**
Kathryn J. Edwards Dec. 1990 124 p
(AD-A230746; AFIT/GE/ENG/90D-18) Avail: NTIS HC/MF A06 CSCL 12/5

As software system requirements become more complex, software engineers must carefully design the systems to ensure that the systems adequately meet all requirements, both functional and non-functional. Because real-time systems have timing constraints, in addition to the more traditional behavioral constraints, a comprehensive software design analysis model is required which incorporates performance, timing, and behavioral constraints. Although the Ada language tasking constructs are compiler independent, Ada tasking is dependent on its runtime environment; therefore, a formal model of Ada tasking and its associated runtime environment is important in order for system designers to make realistic decisions when modeling mission critical computer resources (MCCR) systems. The main focus of this thesis is to determine the feasibility of developing a parameterized, formal model of Ada tasking and the associated runtime environment. This research shows that such a parameterized model can be developed using a mathematical model which incorporates real-time scheduling and queueing theory. This model can be used in future to develop a design analysis environment for real-time embedded software systems that require Ada as the target language. Thus, given a specification for such a system, the design analysis environment can be used to obtain the information needed to support Ada software design decisions. GRA

**N91-20772#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**NETWORK REDUCTION USING ERROR PREDICTION M.S. Thesis**
Michael V. Gilsdorf Dec. 1990 88 p
(AD-A230755; AFIT/GE/ENG/90D-24) Avail: NTIS HC/MF A05 CSCL 23/3

Gradient descent learning algorithms are studied for multilayer feed forward neural networks. A technique is developed which uses error prediction to reduce the number of weights/nodes in a network. The research begins by studying the first and second order back-prop training algorithms along with their convergence properties. A network is reduced by making an estimate of the amount of error which would occur when a weight(s) is removed. This error estimate is then used to determine if a particular weight is essential to the operation of the network. If not, it is removed and the network retrained. The process is repeated until the network is reduced to the desired size, or the error becomes unacceptable. GRA

**N91-20773#** Naval Research Lab., Washington, DC.
**INTERFIS: A NATURAL LANGUAGE INTERFACE TO THE FAULT ISOLATION SHELL Report, for Oct. 1988 - May 1989**
Dennis Perzanowski and Brian Potter 31 Dec. 1990 24 p
(AD-A230780; NRL-9299) Avail: NTIS HC/MF A03 CSCL 12/5

InterFIS is described as a syntactically based natural language interface to a model-based expert system, FIS (Fault Isolation Shell). FIS diagnoses probable cause of failure of avionics in an interactive troubleshooting session and assigns blame by using probabilistic reasoning. InterFIS provides the FIS user with a non-tool-specific interface and permits linguistic complexity and paraphrasability in natural language interactions. InterFIS, driven by the Proteus chart parser, maps syntactic-semantic representations into domain predicates that are then mapped into representations corresponding to the various FIS commands. FIS responds in either a graphic or text mode. It is reported how by using natural English commands and queries as input to the expert system shall, the mnemonic commands of the menu interface to FIS were extended. How some of the capabilities of the expert system are extended without changing any of its functionality. The research approaches are discussed and conclude with implications and questions raised by the work. GRA

**N91-20774#** Laboratoire d'Automatique et d'Analyse des Systemes, Toulouse (France).
**DEPENDABILITY VALIDATION BY MEANS OF INJECTION: METHOD, IMPLEMENTATION, APPLICATION Ph.D. Thesis - Institut National Polytechnique de Toulouse**
Jean Arlat 1990 199 p In FRENCH; ENGLISH summary
(LAAS-90399; ETN-91-98890) Avail: NTIS HC/MF A09

Theoretical and practical results on the use of fault injection as a means for testing fault tolerance in the framework of the

experimental dependability validation of computer systems is discussed. State of the art published work on fault injection, encompassing both hardware (fault simulation, physical fault injection) and software (mutation testing) issues is presented. The major attributes of fault injection (faults and their activation, experimental readouts and measures) are characterized taking into account the abstraction levels used to represent the system during the various phases of its development (analytical, empirical and physical models), and the validation objectives (verification and evaluation). An evaluation method is proposed that combines the analytical modeling approaches (Monte Carlo simulations, closed form expression, Markov chains) used for the representation of the fault occurrence process and the experimental fault injection approaches (fault simulation and physical injection) characterizing the error processing and fault treatment provided by the fault tolerance mechanisms. An experimental tool (MESSALINE), enabling physical faults to be injected into a hardware and software prototype of the system for validation purposes, is presented. Application of MESSALINE for testing two fault tolerant systems possessing very dissimilar features and the utilization of the experimental results obtained, both as design feedbacks and for dependability measures evaluation, is used to illustrate the relevance of the method. ESA

**N91-20775#** Ecole Nationale Superieure des Telecommunications, Paris (France). Groupe Image.
**ON THE CONVERGENCE OF STRAT'S SHAPE FROM SHADING METHOD**
J. D. Durou and H. Maitre Sep. 1990 26 p Submitted for publication
(TELECOM-90-C-004; ISSN-0751-1337; ETN-91-98896) Avail: NTIS HC/MF A03

The issue of convergence in the Strat method of shape from shading analysis is discussed. Convergence of the method has not been conclusively shown. Experiments with different object shapes have in fact shown that divergence often occurs. It is shown that in the case of images containing at least four pixels forming a square, Strat's method often diverges. The notations and formalism used in Strats method are reviewed. A means of predicting convergence to a solution is shown. ESA

**N91-20776#** Ecole Nationale Superieure des Telecommunications, Paris (France). Groupe Image.
**THEORETICAL STUDY OF THE STRAT SHAPE SHADING ALGORITHM [ETUDE THEORIQUE DE L'ALGORITHME DE STRAT DE FORME A PARTIR DE L'OMBRAGE]**
Jean-Denis Durou 29 Aug. 1990 50 p In FRENCH
(TELECOM-90-D-008; ISSN-0751-1345; ETN-91-98897) Avail: NTIS HC/MF A03

The convergence of a relief recognition algorithm using shape from shading (known as the Strat algorithm) is studied and shown not to converge for the majority of cases. The spectral beam of a family of matrices is studied and a relationship between the convergence of the algorithm and the beam (spectral) of an associated matrix is established. ESA

**N91-20777#** Ecole Nationale Superieure des Telecommunications, Paris (France).
**CODE AND MODIFICATION ALGORITHMS OF PROSODIC PARAMETERS FOR SPEECH SYNTHESIS FROM TEXT Ph.D. Thesis [ALGORITHMES DE CODAGE ET DE MODIFICATION DES PARAMETRES PROSIDIQUES POUR LA SYNTHESE DE PAROLE A PARTIR DU TEXTE]**
Eric Moulines 1990 162 p In FRENCH
(TELECOM-90-E-004; ISSN-0751-1353; ETN-91-98899) Avail: NTIS HC/MF A08

The shortcomings of speech quality in automatic reading systems are outlined. The steps involved in converting a text into clear spoken sound are discussed. Phonetic structure analysis and underlying syntax of phrases must be taken into consideration as a first step. The rythmic quality of phrases must be taken into account. The last stage, that of converting the signal into voice, is studied. The various methods available are discussed and evaluated. The research is carried out on systems synthesizing from French texts. ESA

**N91-20778#** Centre National d'Etudes Spatiales, Toulouse (France).
**STUDIES AND IMPLEMENTATIONS OF THE PRINCIPLE REED-SOLOMON DECODING ALGORITHMS [ETUDES ET MISES EN OEUVRE DES PRINCIPAUX ALGORITHMES DE DECODAGE DE REED-SOLOMON]**
Max Ferreol Feb. 1990 141 p In FRENCH; ENGLISH summary
(CNES-NT-123; ETN-91-98902) Copyright Avail: NTIS HC/MF A07

A Reed-Solomon encoder and the Galois field multipliers scheme are described. The algorithms used to compute the error location and error evaluation polynomials are presented. A method of computing error values based on the fast Fourier transform is described. A method used along with the Dornstetter algorithm to compute the error location and error evaluation of polynomials is described. Comparison of different Reed-Solomon decoding processes is carried out. ESA

**N91-20779#** Royal Signals and Radar Establishment, Malvern (England).
**WHICH THEOREM PROVER (A SURVEY OF FOUR THEOREM PROVERS)**
A. Smith Oct. 1990 36 p
(RSRE-Memo-4430; BR115807; ETN-91-99001) Copyright Avail: NTIS HC/MF A03

When using formal methods to produce verified software, mathematical theorems arise which need to be proved. The experiences gained in using four theorem provers to prove such theorems are described. The proof of a relatively deep theorem, the condense theorem, is compared using: Edinburgh IPE (Interactive Proof Editor), m-NEVER (from the m-EVES verification system), HOLM, and the B tool. From this experience, a number of recommendations on what constitutes a good theorem prover are made. ESA

**N91-20780#** Royal Signals and Radar Establishment, Malvern (England).
**FORMAL SEMANTIC DEFINITION OF ELLA TIMING**
M. G. Hill, E. V. Whiting, and J. D. Morison Nov. 1990 22 p
(RSRE-Memo-4436; BR115854; ETN-91-99002) Copyright Avail: NTIS HC/MF A03

The semantics of ELLA delays are informally described. A formal definition of the ELLA timing model is presented using the notation of predicate calculus. The definition of the new sample primitive used for the retiming of ELLA circuits is also given. The concept of hierarchically timescaled regions is presented. Examples of retimed circuits are provided. ESA

**N91-20781#** Royal Signals and Radar Establishment, Malvern (England).
**SPRITE-ELLA LANGUAGE ENHANCEMENTS**
M. G. Hill, E. V. Whiting, and J. D. Morison Nov. 1990 30 p
(RSRE-Memo-4441; BR115852; ETN-91-99003) Copyright Avail: NTIS HC/MF A03

Language enhancements to the hardware description language ELLA (TM), which were carried out for the ESPRIT SPRITE project 2260 are discussed. ELLA was chosen as an input language to the cathedral silicon compilers. These enhancements include naming of output signals, multiple identifier declarations, multiple instantiation of functions and advanced connectivity of circuits. A new primitive was added to the language for extending the timing model. The syntactic and semantic definitions of the enhancements together with examples of text are presented. ESA

**N91-20782#** Stanford Linear Accelerator Center, CA.
**INTRODUCTION TO AMIGAT(SUB E)X**
A. J. Weinstein and M. Weinstein 15 Feb. 1991 23 p

(Contract DE-AC03-76SF-00515)
(DE91-008518; SU-SLAC-TN-91-1) Avail: NTIS HC/MF A03

Amiga T(sub E)X is the Amiga's version of T(sub E)X, Donald Knuth's computer typesetting system, designed to take a text file and produce a printed manuscript. People who have used T(sub E)X on the IBM mainframe know that producing a final copy using the T(sub E)X system involves three independent steps. First, one uses an editor, e.g. XEDIT, to prepare the text file; next, one T(sub E)X's the file in order to produce a device independent (DVI) file; finally, one uses the program IMATEX to send the DVI file to a laser printer. Using T(sub E)X on a personal computer involves the same sequence of steps. In the cast of the Commodore Amiga, the editor is probably TxEd Plus and the T(sub E)X program will be Amiga T(sub E)X. One major difference between the IBM mainframe and the Amiga environment is that one does not have to print a T(sub E)X file in order to read it. One can instead use another program, Preview, to display the formatted file on the screen. In general, the output produced by T(sub E)X is far superior to that produced by a 'What You See Is What You Get' word processor; that is especially true for technical documents. Also, because the files which T(sub E)X uses are plain text files, transporting such files from site to site or machine to machine is straightforward. For these reasons SLAC uses T(sub E)X to prepare most technical documents. The only disadvantage to using T(sub E)X is that learning to use all of the power at your command takes some time. Fortunately, most people don't want to use all this power, they just want to get their work done in as straightforward a manner as possible. Learning to do this is not so difficult, especially if one begins on a machine like the Amiga which can set up to provide a user friendly interface to T(sub E)X. The aim of this document is to provide an introduction to the Amiga's T(sub E)X environment for the novice user. DOE

**N91-20783*#** Cornell Univ., Ithaca, NY. Dept. of Computer Science.
**CONSISTENT DETECTION OF GLOBAL PREDICATES**
Robert Cooper and Keith Marzullo Apr. 1991 20 p Submitted for publication
(Contract NAG2-593; N00140-87-C-8904)
(NASA-CR-188078; NAS 1.26:188078; TR-91-1200) Avail: NTIS HC/MF A03 CSCL 09B

A fundamental problem in debugging and monitoring is detecting whether the state of a system satisfies some predicate. If the system is distributed, then the resulting uncertainty in the state of the system makes such detection, in general, ill-defined. Three algorithms are presented for detecting global predicates in a well-defined way. These algorithms do so by interpreting predicates with respect to the communication that has occurred in the system. Author

**N91-20784*#** Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
**SYSTEM CHARACTERIZATION OF POSITIVE REAL CONDITIONS**
Q. Wang, J. L. Speyer, and H. Weiss (Rafael Armament Development Authority, Haifa, Israel ) 1991 11 p
(Contracts NCC9-16; F08635-87-K-0417)
(NASA-CR-188113; NAS 1.26:188113) Avail: NTIS HC/MF A03 CSCL 09B

Necessary and sufficient conditions for positive realness in terms of state space matrices are presented under the assumption of complete controllability and complete observability of square systems with independent inputs. As an alternative to the positive real lemma and to the s-domain inequalities, these conditions provide a recursive algorithm for testing positive realness which result in a set of simple algebraic conditions. By relating the positive real property to the associated variational problem, a unified derivation of necessary and sufficient conditions for optimality of both singular and nonsingular problems is derived. Author

**N91-20785*#** Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
**RESEARCH IN SOFTWARE ALLOCATION FOR ADVANCED MANNED MISSION COMMUNICATIONS AND TRACKING SYSTEMS Final Report**
Tom Warnagiris, Bill Wolff, and Antone Kusmanoff (Southwest Research Inst., San Antonio, TX.) Dec. 1990 87 p
(Contract NCC9-16)
(NASA-CR-188114; NAS 1.26:188114) Avail: NTIS HC/MF A05 CSCL 09B

An assessment of the planned processing hardware and software/firmware for the Communications and Tracking System of the Space Station Freedom (SSF) was performed. The intent of the assessment was to determine the optimum distribution of software/firmware in the processing hardware for maximum throughput with minimum required memory. As a product of the assessment process an assessment methodology was to be developed that could be used for similar assessments of future manned spacecraft system designs. The assessment process was hampered by changing requirements for the Space Station. As a result, the initial objective of determining the optimum software/firmware allocation was not fulfilled, but several useful conclusions and recommendations resulted from the assessment. It was concluded that the assessment process would not be completely successful for a system with changing requirements. It was also concluded that memory requirements and hardware requirements were being modified to fit as a consequence of the change process, and although throughput could not be quantitized, potential problem areas could be identified. Finally, inherent flexibility of the system design was essential for the success of a system design with changing requirements. Recommendations resulting from the assessment included development of common software for some embedded controller functions, reduction of embedded processor requirements by hardwiring some Orbital Replacement Units (ORUs) to make better use of processor capabilities, and improvement in communications between software development personnel to enhance the integration process. Lastly, a critical observation was made regarding the software integration tasks did not appear to be addressed in the design process to the degree necessary for successful satisfaction of the system requirements. Author

**N91-20786*#** Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
**SPACECRAFT SOFTWARE TRAINING NEEDS ASSESSMENT RESEARCH Final Report**
Shirley Ratcliff and Katharine Golas (Southwest Research Inst., Houston, TX.) 27 Apr. 1990 31 p
(Contract NCC9-16)
(NASA-CR-188103; NAS 1.26:188103) Avail: NTIS HC/MF A03 CSCL 09B

The problems were identified, along with their causes and potential solutions, that the management analysts were encountering in performing their jobs. It was concluded that sophisticated training applications would provide the most effective solution to a substantial portion of the analysts' problems. The remainder could be alleviated through the introduction of tools that could help make retrieval of the needed information from the vast and complex information resources feasible. Y.S.

**N91-20787*#** Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
**SPACECRAFT SOFTWARE TRAINING NEEDS ASSESSMENT RESEARCH, APPENDICES**
Shirley Ratcliff and Katharine Golas (Southwest Research Inst., Houston, TX.) 27 Apr. 1990 75 p
(Contract NCC9-16)
(NASA-CR-188104; NAS 1.26:188104) Avail: NTIS HC/MF A04 CSCL 09B

The appendices to the previously reported study are presented: statistical data from task rating worksheets; SSD references; survey forms; fourth generation language, a powerful, long-term solution

to maintenance cost; task list; methodology; SwRI's instructional systems development model; relevant research; and references. Y.S.

**N91-20788*#** Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
**EXPERT SYSTEM VERIFICATION AND VALIDATION STUDY. DELIVERY 1: SURVEY AND INTERVIEW QUESTIONS**
22 Jun. 1990 17 p Prepared in cooperation with International Business Machines Corp., Houston, TX
(Contract NCC9-16)
(NASA-CR-188111; NAS 1.26:188111) Avail: NTIS HC/MF A03 CSCL 09B

The NASA funded questionnaire is presented to help define the state-of-the-practice in the formal evaluation of Expert Systems on current NASA and industry applications. The answers to this questionnaire, together with follow-up interviews, will provide realistic answers to the following questions: (1) How much evaluation is being performed; (2) What evaluation techniques are in use; and (3) What, if any, are the unique issues in evaluating Expert Systems. Y.S.

**N91-20789*#** Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
**EXPERT SYSTEM VERIFICATION AND VALIDATION SURVEY. DELIVERY 2: SURVEY RESULTS**
15 Aug. 1990 40 p Prepared in cooperation with International Business Machines Corp., Houston, TX
(Contract NCC9-16)
(NASA-CR-188110; NAS 1.26:188110) Avail: NTIS HC/MF A03 CSCL 09B

The purpose is to determine the state-of-the-practice in Verification and Validation (V and V) of Expert Systems (ESs) on current NASA and industry applications. This is the first task of the series which has the ultimate purpose of ensuring that adequate ES V and V tools and techniques are available for Space Station Knowledge Based Systems development. The strategy for determining the state-of-the-practice is to check how well each of the known ES V and V issues are being addressed and to what extent they have impacted the development of ESs. Y.S.

**N91-20790*#** Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
**EXPERT SYSTEM VERIFICATION AND VALIDATION STUDY. PHASE 2: REQUIREMENTS IDENTIFICATION. DELIVERY 1: UPDATED SURVEY REPORT**
14 Dec. 1990 58 p Prepared in cooperation with International Business Machines Corp., Houston, TX
(Contract NCC9-16)
(NASA-CR-188109; NAS 1.26:188109) Avail: NTIS HC/MF A04 CSCL 09B

The purpose is to report the state-of-the-practice in Verification and Validation (V and V) of Expert Systems (ESs) on current NASA and Industry applications. This is the first task of a series which has the ultimate purpose of ensuring that adequate ES V and V tools and techniques are available for Space Station Knowledge Based Systems development. The strategy for determining the state-of-the-practice is to check how well each of the known ES V and V issues are being addressed and to what extent they have impacted the development of Expert Systems. Y.S.

**N91-20791*#** Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
**EXPERT SYSTEM VERIFICATION AND VALIDATION STUDY. PHASE 2: REQUIREMENTS IDENTIFICATION. DELIVERY 2: CURRENT REQUIREMENTS APPLICABILITY**
31 Jan. 1991 28 p Prepared in cooperation with International Business Machines Corp., Houston, TX
(Contract NCC9-16)
(NASA-CR-188108; NAS 1.26:188108) Avail: NTIS HC/MF A03 CSCL 09B

The second phase of a task is described which has the ultimate purpose of ensuring that adequate Expert Systems (ESs) Verification and Validation (V and V) tools and techniques are available for Space Station Freedom Program Knowledge Based Systems development. The purpose of this phase is to recommend modifications to current software V and V requirements which will extend the applicability of the requirements to NASA ESs. Y.S.

**N91-20792*#** Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
**EXPERT SYSTEM VERIFICATION AND VALIDATION SURVEY. DELIVERY 3: RECOMMENDATIONS**
31 Aug. 1990 46 p Prepared in cooperation with International Business Machines Corp., Houston, TX
(Contract NCC9-16)
(NASA-CR-188107; NAS 1.26:188107) Avail: NTIS HC/MF A03 CSCL 09B

The purpose is to determine the state-of-the-practice in Verification and Validation (V and V) of Expert Systems (ESs) on current NASA and Industry applications. This is the first task of a series which has the ultimate purpose of ensuring that adequate ES V and V tools and techniques are available for Space Station Knowledge Based Systems development. The strategy for determining the state-of-the-practice is to check how well each of the known ES V and V issues are being addressed and to what extent they have impacted the development of ESs. Y.S.

**N91-20793*#** Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
**EXPERT SYSTEM VERIFICATION AND VALIDATION SURVEY, DELIVERY 4 Final Report**
14 Sep. 1990 50 p Prepared in cooperation with International Business Machines Corp., Houston, TX
(Contract NCC9-16)
(NASA-CR-188106; NAS 1.26:188106) Avail: NTIS HC/MF A03 CSCL 09B

The purpose is to determine the state-of-the-practice in Verification and Validation (V and V) of Expert Systems (ESs) on current NASA and Industry applications. This is the first task of a series which has the ultimate purpose of ensuring that adequate ES V and V tools and techniques are available for Space Station Knowledge Based Systems development. The strategy for determining the state-of-the-practice is to check how well each of the known ES V and V issues are being addressed and to what extent they have impacted the development of ESs. Author

**N91-20794*#** Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
**EXPERT SYSTEM VERIFICATION AND VALIDATION SURVEY. DELIVERY 5: REVISED Final Report**
31 Oct. 1990 56 p Prepared in cooperation with International Business Machines Corp., Houston, TX
(Contract NCC9-16)
(NASA-CR-188105; NAS 1.26:188105) Avail: NTIS HC/MF A04 CSCL 09B

The purpose is to determine the state-of-the-practice in Verification and Validation (V and V) of Expert Systems (ESs) on current NASA and Industry applications. This is the first task of a series which has the ultimate purpose of ensuring that adequate ES V and V tools and techniques are available for Space Station Knowledge Based Systems development. The strategy for determining the state-of-the-practice is to check how well each of the known ES V and V issues are being addressed and to what extent they have impacted the development of ESs. Author

**N91-20795*#** Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
**THE XPRESS TRANSFER PROTOCOL (XTP): A TUTORIAL (SHORT VERSION)**
Robert M. Sanders and Alfred C. Weaver (Virginia Univ., Charlottesville.) Jan. 1990 19 p
(Contract NCC9-16)
(NASA-CR-188086; NAS 1.26:188086) Avail: NTIS HC/MF A03 CSCL 09B

The Xpress Transfer Protocol (XTP) is a reliable, light weight transfer layer protocol. Current transport layer protocols such as DoD's Transmission Control Protocol (TCP) and ISO's Transport Protocol (TP) were not designed for the next generation of high speed, interconnected reliable networks such as fiber distributed data interface (FDDI) and the gigabit/second wide area networks. Unlike all previous transport layer protocols, XTP is being designed to be implemented in hardware as a VLSI chip set. By streamlining the protocol, combining the transport and network layers, and utilizing the increased speed and parallelization possible with a VLSI implementation, XTP will be able to provide the end-to-end data transmission rates demanded in the high speed networks without compromising reliability and functionality. This tutorial briefly describes the operation of the XTP protocol and in particular, its error, flow and rate control; inter-networking addressing mechanisms; and multicast support features, as defined in the XTP Protocol Definition Revision 3.4. M.G.

**N91-20796*#** Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
**THE XPRESS TRANSFER PROTOCOL (XTP): A TUTORIAL (EXPANDED VERSION)**
Robert M. Sanders and Alfred C. Weaver (Virginia Univ., Charlottesville.) Jan. 1990 73 p
(Contract NCC9-16)
(NASA-CR-188085; NAS 1.26:188085) Avail: NTIS HC/MF A04 CSCL 09B

The Xpress Transfer Protocol (XTP) is a reliable, real-time, light weight transfer layer protocol. Current transport layer protocols such as DoD's Transmission Control Protocol (TCP) and ISO's Transport Protocol (TP) were not designed for the next generation of high speed, interconnected reliable networks such as fiber distributed data interface (FDDI) and the gigabit/second wide area networks. Unlike all previous transport layer protocols, XTP is being designed to be implemented in hardware as a VLSI chip set. By streamlining the protocol, combining the transport and network layers and utilizing the increased speed and parallelization possible with a VLSI implementation, XTP will be able to provide the end-to-end data transmission rates demanded in high speed networks without compromising reliability and functionality. This paper describes the operation of the XTP protocol and in particular, its error, flow and rate control; inter-networking addressing mechanisms; and multicast support features, as defined in the XTP Protocol Definition Revision 3.4. M.G.

**N91-20214*#** Wentworth Inst., Boston, MA.
**THE USE OF COMPUTERS IN A MATERIALS SCIENCE LABORATORY**
J. P. Neville *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 31-33 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 09B

**N91-20693*#** Houston Univ., TX. Dept. of Psychology.
**THE DEVELOPMENT OF EXPERTISE USING AN INTELLIGENT COMPUTER-AIDED TRAINING SYSTEM**
Debra Steele Johnson *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 418-423 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

**N91-20698*#** Inference Corp., El Segundo, CA.
**ART-Ada: AN Ada-BASED EXPERT SYSTEM TOOL**
S. Daniel Lee and Bradley P. Allen *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 456-463 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

**N91-20699*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**ADVANCED CLIPS CAPABILITIES**
Gary Riley *In its* Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 464-468 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

**N91-20701*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**THE ADVANCED SOFTWARE DEVELOPMENT WORKSTATION PROJECT**
Ernest M. Fridge, III and Charles L. Pitman *In its* Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 477-480 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

# 62 COMPUTER SYSTEMS

Includes computer networks and special application computer systems.

**N91-20797** Tel-Aviv Univ. (Israel). Dept. of Computer Science.
**PDEB (PARALLEL DEBUGGER): A DEBUGGER FOR A SHARED MEMORY PARALLEL COMPUTER M.S. Thesis**
Doron Zifrony Jul. 1989 101 p
(ITN-91-85088) Copyright Avail: Tel-Aviv Univ., Exact Sciences Library, Ramat Aviv 69978, Israel

This thesis describes a novel parallel debugger for a MIMD (multiple instruction multiple data) shared memory parallel computer. It was designed and implemented on a shared bus parallel machine based on National Semiconductor's 32000-based boards. An operating system kernel, MMX, has been written to support parallelism on this machine. The debugger, Pdeb, is built of hierarchical layers, where each layer handles a certain debugging level. The lowest level is the board's supplied EPROM monitor, handling symbolic debugging at the board level. National Semiconductor's supplied symbolic debugger is the intermediate level, handling a single board's source level debugging, and the parallel debugger is the uppermost level, handling the complete parallel program. Pdeb uses SUN workstations with the SunView windowing system for its user interface. It supports among other features, conditional breakpoints, variable tracing and watching, variable manipulation and recording of the debugging session, including program's output. Breakpoints may be placed at the task level, both for local and global tasks. Plans for future implementation include a master frame to control overall debugging and to draw the user's attention to interesting events, and graphics to depict the status of the tasks and processors. Author (ISA)

**N91-20798** Tel-Aviv Univ. (Israel). Dept. of Computer Science.
**MODELS FOR CONCURRENCY IN NESTED TRANSACTIONS SYSTEMS M.S. Thesis**
Tova Milo Aug. 1989 76 p In HEBREW; ENGLISH summary
(ITN-91-85091) Copyright Avail: Tel-Aviv Univ., Exact Sciences Library, Ramat Aviv 69978, Israel

Today's standard model for database concurrency control, called serializability theory, represents the executions of transactions as partial orders of operations. The theory tells when an execution is serializable, i.e., when a set of operations will execute automatically with respect to those of other transactions. The model has been used successfully to prove the correctness of most database concurrency control algorithms. Its most serious limitation is the inability to present nested computations conveniently. Two formal models have been developed for reasoning about nested transaction systems, the Extended Operations Model and the Events Model. The Events Model enables the precise analysis of transaction systems by modelling each system component as an 'I/O automation.' The basic elements of a computation are events. The model is extrememly detailed and, therefore, very complex. Correctness proofs are long

and not intuitive. The basic elements of the Operations Model are atomic operations. The model is much simpler and easier to understand. However, it offers a less precise description of the behavior of the system. This paper shows that for a large class of systems we can avoid the complexity of the Events Model and, instead, use the Operations Model for describing the system and for proving correctness of algorithms. We describe a mapping between the various components of the two models. We discuss each component of the system, and the system's computations and proof technique. By describing the close relationship between the two models, we not only show that the Operations Model describes the system precisely, but also that anything that can be done in the Events Model can also be done using techniques from the Operations Model. We also show a proof technique called 'reduction' which was developed in the Operations Model, but has not yet been presented in the Events model. We describe its implementation in the Events Model. Author (ISA)

**N91-20799#** Massachusetts Inst. of Tech., Cambridge. Lab. for Computer Science.
**ON-LINE SCHEDULING OF PARALLEL MACHINES**
Joel Wein and David P. Williamson Nov. 1990 18 p
(Contracts N00014-89-J-1988; N00014-87-K-0825; NSF CCR-89-96272; AF-AFOSR-0271-89)
(AD-A230070; MIT/LCS/TM-437) Avail: NTIS HC/MF A03 CSCL 12/4

We study the problem of scheduling jobs on parallel machines in an on-line fashion, where the processing requirement of a job is not known until the job is completed. Despite this lack of knowledge of the future, we wish to schedule in a way that minimizes the completion time of the entire set of jobs. In general, the performance of an on-line algorithm is measured by its competitive ratio: the worst case ratio of its performance to that of an optimal algorithm with total prior knowledge. We study two fundamental models for this problem, that of identical machines, where all the machines run at the same speed, and uniformly related machines, where the machine run at different speeds. Our results include: (1) matching upper and lower bounds on the competitive ratio for the case of identical machines; (2) upper and lower bounds that differ by a constant factor for uniformly related machines; (3) a lower bound for randomized algorithms for identical machines that nearly matches the deterministic upper bound; and (4) several upper and lower bounds for variations on these models. Author (GRA)

**N91-20800#** Washington Univ., Seattle. Dept. of Computer Science.
**ADVANCED NUMERICAL TECHNIQUES OF PERFORMANCE EVALUATION, VOLUME 1 Final Report**
Jun. 1990 277 p
(Contract N66001-87-D-0136)
(AD-A230292; NOSC-TD-1837-Vol-1) Avail: NTIS HC/MF A13 CSCL 12/5

The following subject areas are covered: PRESTO - A System for Object-oriented Parallel Programming; The Performance of Parallel Computer Systems; The PRESTO User's Manual; An Open Environment for Building Parallel Programming Systems. GRA

**N91-20801#** Washington Univ., Seattle. Dept. of Computer Science.
**ADVANCED NUMERICAL TECHNIQUES OF PERFORMANCE EVALUATION, VOLUME 2 Final Report**
Jun. 1990 502 p
(Contract N66001-87-D-0136)
(AD-A230293; NOSC-TD-1837-Vol-2) Avail: NTIS HC/MF A22 CSCL 12/5

The conservative (Bryant-Chandy-Misra) parallel simulation paradigm was originally developed in a distributed system setting. However, the recent widespread availability of relatively inexpensive, medium-scale shared memory multiprocessors encourages a re-examination of traditional approaches to its implementation. Many of the obstacles to good performance, such as communication delay, sub-optimal model partitioning, artificial blocking, and the high cost of deadlock avoidance, deadlock detection, and deadlock recovery, can be reduced or even eliminated in a shared-memory implementation. This paper presents a number of techniques for efficient in a shared memory parallel simulation. All of these techniques have been implemented in Synapse, an integrated programming environment/run-time system that supports efficient parallel discrete-event simulation on shared-memory multiprocessors. A new technique for artificial blocking and deadlock avoidance, lazy blocking avoidance, is built directly into Synapse's multi-threaded run-time kernel. The Synapse run-time system also contains mechanisms for efficiently detecting and breaking the few deadlocks that are not prevented by lazy blocking avoidance. Our performance results are substantially better than those reported in previous empirical studies in this area, enough to challenge their negative conclusions about the feasibility of the conservative approach to parallel simulation. GRA

**N91-20802#** Stanford Univ., CA.
**ASYNCHRONOUS DESIGN FOR PARALLEL PROCESSING ARCHITECTURES Semiannual Report, Jul. - Dec. 1990**
Teresa H. Meng 1991 2 p
(Contract N00014-89-J-3036)
(AD-A230374) Avail: NTIS HC/MF A01 CSCL 09/1

The objective of this research is to provide an interconnect synthesis methodology which facilitates a modular design approach without compromising the global performance. The main tasks of this effort will be the development of the theory for optimal interconnect circuit synthesis from a high-level specification, with emphasis on testability and fault-tolerance asynchronous interface among concurrently computing hardware, and the application of this design methodology to physical implementations of parallel processing systems. The major research effort has been directed toward the testability of asynchronous circuits. Testability has become a major design consideration in integrated circuit industry and the question that whether asynchronous circuits would simplify the testing tasks is to be answered. Asynchronous combinational circuits had been shown to be fully testable with single-stuck-at-faults (SSAFs) if precharged circuits were used for implementation; however, the testability of asynchronous control circuits (sequential circuits with environmental constraints) had not been addressed. Level-sensitive scan-path design can be used to aid testing in asynchronous sequential circuits, but scan-path design usually requires too long a testing day. The interest is in incorporating testability directly into circuit synthesis. The problem of testability is considered for two areas of asynchronous design: speed-independent circuits and self-timed circuits. GRA

**N91-20803#** Naval Research Lab., Washington, DC.
**EXPLICIT STATE VECTOR REPRESENTATION FOR HETEROASSOCIATIVE MEMORIES**
Jeffrey K. Uhlmann 21 Nov. 1990 8 p
(AD-A229757; NRL-9283) Avail: NTIS HC/MF A02 CSCL 12/3

In summary, it has been shown that the commutative correlation operator used in most linear associative memory (AM) models enforces symmetries that preclude the learning of several classes of important mapping functions. It has also been shown, however, that these symmetries can be eliminated simply by using a different information representation scheme. The explicit state (ES) representation has been proposed as an alternative to the commonly used bipolar form and has been demonstrated to permit standard AM architectures to learn nonlinear mappings. In particular, it has been shown that the ES representation permits first-order AM models to learn nonlinear transformations of the form $y = xT + b$. This characterization is important because its properties are directly amenable to analysis by using the known properties of affine transformation. For example, it has been noted that this transformation renders the ES formulation immune to the effects of constant additive noise. It has also been shown that the ES representation can be easily generalized for the use of higher order correlation information. GRA

**N91-20804*#** Delaware Univ., Newark. Dept. of Electrical Engineering.
**HIGHBALL: A HIGH SPEED, RESERVED-ACCESS, WIDE AREA NETWORK**
David L. Mills, Charles G. Boncelet, John G. Elias, Paul A. Schragger, and Alden W. Jackson Sep. 1990 38 p
(Grants NAG2-638; NSF NCR-89-13623)
(NASA-CR-188070; NAS 1.26:188070; TR-90-9-3) Avail: NTIS HC/MF A03 CSCL 09B

A network architecture called Highball and a preliminary design for a prototype, wide-area data network designed to operate at speeds of 1 Gbps and beyond are described. It is intended for applications requiring high speed burst transmissions where some latency between requesting a transmission and granting the request can be anticipated and tolerated. Examples include real-time video and disk-disk transfers, national filestore access, remote sensing, and similar applications. The network nodes include an intelligent crossbar switch, but have no buffering capabilities; thus, data must be queued at the end nodes. There are no restrictions on the network topology, link speeds, or end-end protocols. The end system, nodes, and links can operate at any speed up to the limits imposed by the physical facilities. An overview of an initial design approach is presented and is intended as a benchmark upon which a detailed design can be developed. It describes the network architecture and proposed access protocols, as well as functional descriptions of the hardware and software components that could be used in a prototype implementation. It concludes with a discussion of additional issues to be resolved in continuing stages of this project. Author

**N91-20805#** Syracuse Univ., NY. Northeast Parallel Architectures Center.
**NORTHEAST PARALLEL ARCHITECTURES CENTER (NPAC) AT SYRACUSE UNIVERSITY Interim Report, Jan. 1988 - Jan. 1989**
William Schraeder Dec. 1990 115 p
(Contract F30602-88-C-0031)
(AD-A230635; RADC-TR-90-340) Avail: NTIS HC/MF A06 CSCL 12/6

This one year summarizes what has been accomplished at the Northeast Parallel Architectures Center during its first year of full operation. The Northeast Parallel Architectures Center promotes and explores advanced computing technology by providing parallel architectures and research support to university, corporate, and government researchers nationwide. The first year was a period to define the organization, acquire hardware and consolidate support and commitment to NPAC's mission. NPAC relied heavily on research faculty from other institutions and from Syracuse University (Colleges of Computer and Information Science, Engineering, Engineering (CASE)) to achieve this goal. This year was a period of rapid growth and development. The machines acquired include: two Connection Machines; two Multimaxes, a 320 and 310; an Alliant FX/80 and a Stellar Graphics Supercomputer. These architectures are discussed in further detail in part two of this report. We also continued to build internal and external relationships, strengthening our local and national reputation. Our facility matured and stabilized. GRA

**N91-20806#** National Aerospace Lab., Tokyo (Japan).
**PARALLEL PROCESSING USING MULTITASKING ON CRAY X-MP SYSTEM**
Kinuyo Nakamura and Masahiro Fukuda Jun. 1990 23 p In JAPANESE; ENGLISH summary
(NAL-TR-1069; ISSN-0389-4010) Avail: NTIS HC/MF A03

The authors investigated parallel processing, using the CRAY X-MP/216 system, which is a supercomputer with multiple vector processors. Multitasking is a microprocessor computer operation mode that executes two or more parts of a single program in parallel. It is one method of high-speed processing. The FORTRAN programs under investigation are those for a subsonic flow over an airfoil, an unsteady transonic flow over a wing, and an inviscid compressible flow through a two-dimensional cascade. These programs were rewritten so that they could be effectively executed on two central processing units (CPUs). The computing times of the original programs with one CPU, multitasked programs with one CPU, and multitasked programs with two CPUs, are discussed. Also covered is the ratio of computing times of the multitasked programs to those of the original program. Author

**N91-20700*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**PARALLEL PROCESSING AND EXPERT SYSTEMS**
Jerry C. Yan (Sterling Federal Systems, Inc., Moffett Field, CA.) and Sonie Lau *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 469-476 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

# 63 CYBERNETICS

Includes feedback and control theory, artificial intelligence, robotics and expert systems.

For related information see also *54 Man/System Technology and Life Support.*

**N91-20807#** University of Southern California, Los Angeles. Signal and Image Processing Inst.
**STABILITY AND ADAPTATION OF NEURAL NETWORKS Annual Technical Report, 1 Aug. 1989 - 31 Jul. 1990**
Bart Kosko 2 Nov. 1990 213 p
(Grant AF-AFOSR-0236-88; AF Proj. 2305)
(AD-A230108; AFOSR-90-1174TR) Avail: NTIS HC/MF A10 CSCL 12/9

Focused on unsupervised learning and adaptive fuzzy systems. Explored the differential competitive learning (DCL) law. DCL were benchmarked against supervised competitive learning for phoneme recognition and centroid estimation. Proved structural stability for general competitive learning laws. Developed product space clustering to develop adaptive fuzzy systems, which grow structured fuzzy rules from training data without supervision. Successfully benchmarked adaptive fuzzy systems against neural network truck-and-trailer systems and Kalman filter control systems for realtime target tracking. GRA

**N91-20808#** Arizona Univ., Tucson. Applied Mathematics Program.
**PROBABILISTIC ANALYSIS OF NEURAL NETWORKS Final Report, 1 Jun. 1988 - 30 Sep. 1990**
William G. Faris and Charles M. Newman 26 Nov. 1990 24 p
(Grant AF-AFOSR-0189-88; AF Proj. 2304)
(AD-A230165; AFOSR-90-1194TR) Avail: NTIS HC/MF A03 CSCL 12/7

The research was a probabilistics study of neural network models. It was not oriented toward the workings of a particular device, but was intended to provide an understanding of the basic mechanisms of learning and recognition in neural networks. The main areas of progress were analysis of neural networks models, study of network connectivity, and investigation of computer network theory. GRA

**N91-20809#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**MODEL-BASED 3-D RECOGNITION SYSTEM USING GABOR FEATURES AND NEURAL NETWORKS M.S. Thesis**
Phung D. Le Dec. 1990 110 p
(AD-A230387; AFIT/GEO/ENG/90D-05) Avail: NTIS HC/MF A06 CSCL 12/9

A different approach to pattern recognition was attempted using Gabor features, artificial neural nets, and an image generator. The Gabor features and artificial neural nets are sound biological-based, and the image generator provides complete access to any view of an object. This thesis tested the idea that their integration could form a robust 3-D recognition system. The results of the research showed that the Gabor features together with a neural

net were used successfully in classifying objects regardless of their positions, out-of-plane rotations, and to a lesser extent in-plane rotations. The Gabor features were obtained by correlating the image with Gabor filters of varying orientations spaced 15 degrees apart as found in primates' visual systems, and the correlation with each filter was kept separately. GRA

**N91-20810#** Lockheed Missiles and Space Co., Palo Alto, CA. Artificial Intelligence Center.
**ADAPTIVE INTERFACES Final Report, Mar. 1989 - May 1990**
Sherman W. Tyler Nov. 1990 29 p
(Contract F30602-87-D-0087)
(AD-A229751; RADC-TR-90-276) Avail: NTIS HC/MF A03
CSCL 23/2

The purpose of this research and development endeavor was to design and implement an adaptive intelligent interface for a command-and-control style domain. The primary functionality of the resulting interface was to be able to adapt its presentation of information to the individual user, based upon the current task and the user's personal preferences and experiences as captured in an explicit user model. The CHORIS (Computer Human Object Oriented Reasoning Interface System) software system is a knowledge based intelligent interface architecture which supports mixed modality input and output, high-level plan management, adaptation to individual users and user roles, and tailoring of system response information to the currently executing high-level task and the user's preferences. CHORIS has been extended to support users with different roles within the command-and-control-style domain of emergency management. The interface demonstrates the powerful effects that the functionality captured within CHORIS can have in enhancing user performance in responding to complex situations in a timely manner. GRA

**N91-20811*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**PROCEEDINGS OF THE SECOND JOINT TECHNOLOGY WORKSHOP ON NEURAL NETWORKS AND FUZZY LOGIC, VOLUME 2**
Robert N. Lea, ed. and James A. Villarreal, ed. Feb. 1991 278 p Workshop held in Houston, TX, 10-13 Apr. 1990; sponsored by NASA, Washington, NASA. Johnson Space Center, and Houston Univ.
(NASA-CP-10061-Vol-2; S-624-Vol-2; NAS 1.55:10061-Vol-2)
Avail: NTIS HC/MF A13 CSCL 09B

Documented here are papers presented at the Neural Networks and Fuzzy Logic Workshop sponsored by NASA and the University of Texas, Houston. Topics addressed included adaptive systems, learning algorithms, network architectures, vision, robotics, neurobiological connections, speech recognition and synthesis, fuzzy set theory and application, control and dynamics processing, space applications, fuzzy logic and neural network computers, approximate reasoning, and multiobject decision making. For individual titles, see N91-20812 through N91-20820.

**N91-20812*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**AN ARCHITECTURE FOR DESIGNING FUZZY LOGIC CONTROLLERS USING NEURAL NETWORKS**
Hamid R. Berenji *In* NASA, Lyndon B. Johnson Space Center, Proceedings of the Second Joint Technology Workshop on Neural Networks and Fuzzy Logic, Volume 2 Feb. 1991 p 1-29 (For primary document see N91-20811 12-63)
Avail: NTIS HC/MF A13 CSCL 09B

Described here is an architecture for designing fuzzy controllers through a hierarchical process of control rule acquisition and by using special classes of neural network learning techniques. A new method for learning to refine a fuzzy logic controller is introduced. A reinforcement learning technique is used in conjunction with a multi-layer neural network model of a fuzzy controller. The model learns by updating its prediction of the plant's behavior and is related to the Sutton's Temporal Difference (TD) method. The method proposed here has the advantage of using the control knowledge of an experienced operator and fine-tuning it through the process of learning. The approach is applied to a cart-pole balancing system. Author

**N91-20813*#** Alabama Univ., Huntsville. Center for Applied Optics.
**AN OVERVIEW OF THE NEURON RING MODEL**
Rod Taber *In* NASA, Lyndon B. Johnson Space Center, Proceedings of the Second Joint Technology Workshop on Neural Networks and Fuzzy Logic, Volume 2 Feb. 1991 p 31-62 (For primary document see N91-20811 12-63)
Avail: NTIS HC/MF A13 CSCL 09B

The Neuron Ring model employs an avalanche structure with two important distinctions at the neuron level. Each neuron has two memory latches; one traps maximum neuronal activation during pattern presentation, and the other records the time of latch content change. The latches filter short term memory. In the process, they preserve length 1 snapshots of activation theory history. The model finds utility in pattern classification. Its synaptic weights are first conditioned with sample spectra. The model then receives a test or unknown signal. The objective is to identify the sample closest to the test signal. Class decision follows complete presentation of the test data. The decision maker relies exclusively on the latch contents. Presented here is an overview of the Neuron Ring at the seminar level. Author

**N91-20814*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**A SPACE-TIME NEURAL NETWORK**
James A. Villarreal and Robert O. Shelton *In its* Proceedings of the Second Joint Technology Workshop on Neural Networks and Fuzzy Logic, Volume 2 Feb. 1991 p 63-80 (For primary document see N91-20811 12-63)
Avail: NTIS HC/MF A13 CSCL 09B

Introduced here is a novel technique which adds the dimension of time to the well known back propagation neural network algorithm. Cited here are several reasons why the inclusion of automated spatial and temporal associations are crucial to effective systems modeling. An overview of other works which also model spatiotemporal dynamics is furnished. A detailed description is given of the processes necessary to implement the space-time network algorithm. Several demonstrations that illustrate the capabilities and performance of this new architecture are given. Author

**N91-20815*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**FUZZY LOGIC IN AUTONOMOUS ORBITAL OPERATIONS**
Robert N. Lea and Yashvant Jani (LinCom Corp., Houston, TX.) *In its* Proceedings of the Second Joint Technology Workshop on Neural Networks and Fuzzy Logic, Volume 2 Feb. 1991 p 81-110 (For primary document see N91-20811 12-63)
Avail: NTIS HC/MF A13 CSCL 09B

Fuzzy logic can be used advantageously in autonomous orbital operations that require the capability of handling imprecise measurements from sensors. Several applications are underway to investigate fuzzy logic approaches and develop guidance and control algorithms for autonomous orbital operations. Translational as well as rotational control of a spacecraft have been demonstrated using space shuttle simulations. An approach to a camera tracking system has been developed to support proximity operations and traffic management around the Space Station Freedom. Pattern recognition and object identification algorithms currently under development will become part of this camera system at an appropriate level in the future. A concept to control environment and life support systems for large Lunar based crew quarters is also under development. Investigations in the area of reinforcement learning, utilizing neural networks, combined with a fuzzy logic controller, are planned as a joint project with the Ames Research Center. Author

**N91-20816*#** Netrologic, Inc., San Diego, CA.
**SPACE SHUTTLE MAIN ENGINE FAULT DETECTION USING NEURAL NETWORKS**

Thomas Bishop, Dan Greenwood, Kenneth Shew, and Fareed Stevenson *In* NASA, Lyndon B. Johnson Space Center, Proceedings of the Second Joint Technology Workshop on Neural Networks and Fuzzy Logic, Volume 2 Feb. 1991 p 115-152 (For primary document see N91-20811 12-63)
Avail: NTIS HC/MF A13 CSCL 09B

A method for on-line Space Shuttle Main Engine (SSME) anomaly detection and fault typing using a feedback neural network is described. The method involves the computation of features representing time-variance of SSME sensor parameters, using historical test case data. The network is trained, using backpropagation, to recognize a set of fault cases. The network is then able to diagnose new fault cases correctly. An essential element of the training technique is the inclusion of randomly generated data along with the real data, in order to span the entire input space of potential non-nominal data. Author

**N91-20817*#** National Science Foundation, Washington, DC.
**NEUROCONTROL AND FUZZY LOGIC: CONNECTIONS AND DESIGNS**
Paul J. Werbos *In* NASA, Lyndon B. Johnson Space Center, Proceedings of the Second Joint Technology Workshop on Neural Networks and Fuzzy Logic, Volume 2 Feb. 1991 p 153-196 (For primary document see N91-20811 12-63)
Avail: NTIS HC/MF A13 CSCL 09B

Artificial neural networks (ANNs) and fuzzy logic are complementary technologies. ANNs extract information from systems to be learned or controlled, while fuzzy techniques mainly use verbal information from experts. Ideally, both sources of information should be combined. For example, one can learn rules in a hybrid fashion, and then calibrate them for better whole-system performance. ANNs offer universal approximation theorems, pedagogical advantages, very high-throughput hardware, and links to neurophysiology. Neurocontrol - the use of ANNs to directly control motors or actuators, etc. - uses five generalized designs, related to control theory, which can work on fuzzy logic systems as well as ANNs. These designs can copy what experts do instead of what they say, learn to track trajectories, generalize adaptive control, and maximize performance or minimize cost over time, even in noisy environments. Design tradeoffs and future directions are discussed throughout. Author

**N91-20818*#** California Univ., Berkeley. Dept. of Electrical Engineering and Computer Sciences.
**INTELLIGENT CONTROL BASED ON FUZZY LOGIC AND NEURAL NET THEORY**
Chuen-Chien Lee *In* NASA, Lyndon B. Johnson Space Center, Proceedings of the Second Joint Technology Workshop on Neural Networks and Fuzzy Logic, Volume 2 Feb. 1991 p 197-208 (For primary document see N91-20811 12-63)
(Contract NCC2-275)
Avail: NTIS HC/MF A13 CSCL 09B

In the conception and design of intelligent systems, one promising direction involves the use of fuzzy logic and neural network theory to enhance such systems' capability to learn from experience and adapt to changes in an environment of uncertainty and imprecision. Here, an intelligent control scheme is explored by integrating these multidisciplinary techniques. A self-learning system is proposed as an intelligent controller for dynamical processes, employing a control policy which evolves and improves automatically. One key component of the intelligent system is a fuzzy logic-based system which emulates human decision making behavior. It is shown that the system can solve a fairly difficult control learning problem. Simulation results demonstrate that improved learning performance can be achieved in relation to previously described systems employing bang-bang control. The proposed system is relatively insensitive to variations in the parameters of the system environment. Author

**N91-20819*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**FUZZY GEOMETRY, ENTROPY, AND IMAGE INFORMATION**
Sankar K. Pal (Indian Statistical Inst., Calcutta.) *In its* Proceedings of the Second Joint Technology Workshop on Neural Networks and Fuzzy Logic, Volume 2 Feb. 1991 p 211-232 (For primary document see N91-20811 12-63)
Avail: NTIS HC/MF A13 CSCL 09B

Presented here are various uncertainty measures arising from grayness ambiguity and spatial ambiguity in an image, and their possible applications as image information measures. Definitions are given of an image in the light of fuzzy set theory, and of information measures and tools relevant for processing/analysis e.g., fuzzy geometrical properties, correlation, bound functions and entropy measures. Also given is a formulation of algorithms along with management of uncertainties for segmentation and object extraction, and edge detection. The output obtained here is both fuzzy and nonfuzzy. Ambiguity in evaluation and assessment of membership function are also described. Author

**N91-20820*#** SRI International Corp., Menlo Park, CA. Artificial Intelligence Center.
**THE SEMANTICS OF FUZZY LOGIC**
Enrique H. Ruspini *In* NASA, Lyndon B. Johnson Space Center, Proceedings of the Second Joint Technology Worshop on Neural Networks and Fuzzy Logic, Volume 2 Feb. 1991 p 233-270 (For primary document see N91-20811 12-63)
(Contracts F49620-89-K-0001; DAAL03-89-K-0156)
Avail: NTIS HC/MF A13 CSCL 09B

Summarized here are the results of recent research on the conceptual foundations of fuzzy logic. The focus is primarily on the principle characteristics of a model that quantifies resemblance between possible worlds by means of a similarity function that assigns a number between 0 and 1 to every pair of possible worlds. Introduction of such a function permits one to interpret the major constructs and methods of fuzzy logic: conditional and unconditional possibility and necessity distributions and the generalized modus ponens of Zadeh on the basis of related metric relationships between subsets of possible worlds. Author

**N91-20821#** California Univ., Berkeley. Dept. of Psychology.
**VISUAL INFORMATION-PROCESSING IN THE PERCEPTION OF FEATURES AND OBJECTS Final Report, 1 Jan. 1987 - 31 Aug. 1990**
Anne Treisman 10 Dec. 1990 19 p
(Grant AF-AFOSR-0125-87; AF Proj. 2313)
(AD-A230488; AFOSR-90-1218TR) Avail: NTIS HC/MF A03 CSCL 20/6

The research explored varios aspects of visual processing in the perception of features and objects. Studies of visual features tested the level of abstraction of the coding of orientation, the emergence of features in surface media defined by texture, motion or depth, and the role of similarity in preattentive representation of coarsely coded values. Object perception was explored in a series of studies requiring subjects to conjoin features, and testing the role played by spatially selective attention. The results suggested a modification of feature integration theory, allowing some preattentive control through feature maps. Evidence was also found for object-specific tokens in the coding of dynamic displays of moving, changing objects. In studies of perceptual learning, extended practice effects were shown to be very specific to details of the practice situation. Finally, visual memory for arbitrary line patterns showed both surprising plasticity (long-lasting traces after a single presentation of 50 patterns) and surprising dissociations between implicit and explicit tests. GRA

**N91-20822#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**A BIOLOGICALLY-INSPIRED NEURAL NETWORK ARCHITECTURE FOR IMAGE PROCESSING M.S. Thesis**
Laurence E. Lazofson Dec. 1990 159 p
(AD-A230495; AFIT/GEO/ENG/90D-04) Avail: NTIS HC/MF A08 CSCL 05/8

This thesis project included a literature survey of biological and artificial neural network research followed by development and testing of high-order and image recognition hierarchical neural network algorithms. Following training, performance testing of

second-order and third-order networks yielded maximum accuracies comparable to those achieved by multilayer perceptron classifiers operating on test data sets. Several versions of an image classification algorithm were tested for learning performance using pixel data from forward-looking infrared (FLIR) images of tanks, trucks, target boards, and clutter. Employing the biologically-motivated Lambertization and contrast normalization of pixel windows, correlations with multiple Gabor function wavelets, and a phase synchronizing local averaging routine, the image classification network extracted data features. Different network versions fed the extracted features to varying output classification schemes. To improve separation of problem classes, recommendations were made for varying the parameters of the Gabor function wavelets and modifying the phase synchronization scheme to extract more suitable features from image pixel data. GRA

**N91-20823#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
**BIOCHIP TECHNOLOGY DEVELOPMENT**
M. D. Eggers, D. J. Ehrlich, D. K. Astolfi, S. G. Cann, and Y. V. Grinbush 9 Nov. 1990 66 p
(Contract F19628-90-C-0002)
(AD-A230564; TR-901; ESD-TR-90-105) Avail: NTIS HC/MF A04 CSCL 06/5

Today the study of biological intelligence constitutes perhaps the most challenging yet rewarding frontier of research. A most compelling notion attracting many researchers is that such complex intelligence originates from a vast interconnected architecture containing approximately 1012 relatively simple computational units or neurons. The massively parallel architecture, sporting approximately 1015 adaptable neural interconnectors, is responsible for the extraordinary pattern processing capabilities of the brain. Among the pattern processing capabilities of interest to machine intelligence researchers pursuing engineering applications are fast pattern recognition by association, apparent infinite memory capacity, generalization, and robust, fault-tolerant performance. Furthermore, these system level capabilities are obtained biologically at modest expense, for the human brain consumes energy at a rate comparable to that of a single VLSI digital signal processing chip. Such efficiency arises from the rather conservative processing units, operating with 1 ms time constants and slowly communicating information (100 ms) along passive neuronal channels. GRA

**N91-20824#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**H2 AND H INFINITY OPTIMIZATION WITH A RESTRICTED REGION OF STABILITY M.S. Thesis**
Michael J. Mares Dec. 1990 115 p
(AD-A230596; AFIT/GAE/ENY/90D-15) Avail: NTIS HC/MF A06 CSCL 12/4

Many modern control design methods, such as H2 and H infinity optimization, guarantee that the closed-loop system will be stable. To make further use of this guarantee, the portion of the s-plane considered to be stable is restricted to a region left of a vertical line some distance alpha from the imaginary axis. This alpha shift was accomplished in the state space equations, so standard computational tools still work. Now the system is not only guaranteed to be stable, but also has some guaranteed speed for the time response. The equations for guaranteeing some arbitrary damping ratio were also derived in Cartesian coordinates, but only the alpha shift was put into the state space equation form and tested. The alpha shift increased the speed of the system, as expected. An additional benefit was increasing the damping of lightly damped poles. The cost for doing this was an increase in the steady state error and an increase in the control power required. GRA

**N91-20825#** Pennsylvania Univ., Philadelphia.
**SMART SENSING AND RECOGNITION BASED ON MODELS OF NEURAL NETWORKS Final Report, 17 Sep. 1987 - 16 Sep. 1990**
N. H. Farhat 15 Nov. 1990 125 p
(Contract DAAL03-87-K-0108)
(AD-A230701; EO-Mo-90-1; ARO-24898.9-EL) Avail: NTIS HC/MF A06 CSCL 17/9

Radar target identification is an important problem to which much attention has been given in the past solution efforts relied predominately on linear signal processing techniques. There are two traditional approaches. In the one, high resolution images are formed to be examined and identified by human observers. In the second, target signatures (feature vectors) are formed for automated machine identification. The first approach is usually quite costly and has several practical limitations stemming from the high cost and large size of microwave imaging apertures. The second approach is yet to provide a reliable scheme. Motivated by the observation that the above approaches are primarily linear and that biological systems, which process information in a highly nonlinear, collective, and frequently iterative manner, are very adapt at carrying out recognition, classification association, and optimization tasks, we elected to investigate the capabilities of collective nonlinear processing in target identification. GRA

**N91-20826#** Teleos Research, Palo Alto, CA.
**THE SYNTHESIS OF INTELLIGENT REAL-TIME SYSTEMS Final Report, Apr. 1989 - Nov. 1990**
Stanley J. Rosenschein and Leslie P. Kaelbling 9 Nov. 1990 178 p
(Contract F49620-89-C-0055)
(AD-A230751; TR-90-03; AFOSR-90-1193TR) Avail: NTIS HC/MF A09 CSCL 12/7

Teleos Research, under the sponsorship of the Air Force Office of Scientific Research, has carried out a two-year program of research on the synthesis of intelligent real-time systems. The purpose of the effort was to develop and extend theories and techniques that facilitate the design and implementation of intelligent real-time systems. In particular, Teleos has done the following: (1) extended situated-automata theory to apply to situations in which the system has probabilistic information about the world; (2) designed and built a high-level, declarative programming tool for synthesizing efficient programs that track dynamic conditions in the world; (3) clarified the theoretical relationships between Gapps, an existing declarative programming tool for describing action strategies, and the newly designed tool; (4) investigated the possibility of moving the burden of developing correct programs from the human programmer to the agent itself through the use of algorithms that allow the agent to learn from trial and error; (5) applied the principles of situated automata theory to the understanding of existing vision algorithms and the development of new ones; and (6) tested these theoretical principles and design tools in a real robotic domain. GRA

**N91-20827#** Texas Univ., Austin. Dept. of Computer Sciences.
**ARTIFICIAL INTELLIGENCE PROJECT Final Technical Report, 25 Jun. 1984 - 31 Aug. 1990**
Gordon S. Novak, Jr., Robert F. Simmons, Bruce W. Porter, Vipin Kumar, and Robert L. Causey 1990 96 p
(Contract DAAG29-84-K-0060)
(AD-A230793; ARO-21683.61-MA-AI) Avail: NTIS HC/MF A05 CSCL 12/9

Some of the project titles are as follows: Automatic Programming by Reuse of Generic Algorithms; Physics Problem Solving; Knowledge Acquisition for Expert Systems; Human Interface Design; Biology Knowledge Base; Knowledge Engineering; Device Descriptions; Text Analysis; Neural Network Explorations; Design, Analysis, and Implementation of Parallel Algorithms; Parallel Architectures for Logic Programs. GRA

**N91-20828#** Laboratoire d'Automatique et d'Analyse des Systemes, Toulouse (France).
**ADAPTIVE PREDICTIVE CONTROL: APPLICATION TO THERMAL PROCESSES M.S. Thesis - Toulouse Univ.**
Joel Bordeneuve-Guibe 1990 135 p In FRENCH; ENGLISH summary
(LAAS-90401; ETN-91-98891) Avail: NTIS HC/MF A07

The state of the art in adaptive control and its evolution to predictive methods are reviewed. Process control problems are tackled. Thermal system control is pointed out. Two extended horizon predictive control algorithms are presented. Generalized predictive control and double model reference control are discussed. They are made adaptative with a parametric adaptation algorithm, that allows this scheme to be used in a real context. Two microelectronic technology techniques, liquid phase epitaxy and rapid thermal annealing are discussed. The liquid phase epitaxy is carried out in a five zone tubular furnace. After an open loop study, a simple method of multi loop control is proposed. Double model reference control shows, in simulation, its ability to solve problems like space time temperature profile tracking. Their advantages over a nonlinear control law are shown. Rapid thermal annealing generates fast thermal dynamics. The capacity of the generalized predictive and double model reference controls to reach the desired objectives fixed by the user, is experimentally evaluated by using two furnaces exhibiting different characteristics, and loaded with various charges. A sensitivity study of the tuning parameters is performed. The performances of both control strategies are analyzed and compared. Generalized predictive control is compared to classical control law with adjustable parameters. Its efficiency is demonstrated through the quality of results and easy parameter tuning. ESA

**N91-20829#** Laboratoire d'Automatique et d'Analyse des Systemes, Toulouse (France).
**INTERACTIVE GRAPHICAL PROGRAMMING OF NONREPETITIVE CONTACT MANIPULATION TASKS Ph.D. Thesis - Toulouse Univ.**
Thierry Trans 1990 150 p In FRENCH; ENGLISH summary
(LAAS-90371; ETN-91-98892) Avail: NTIS HC/MF A07

Development of programming aid and theoretical methods for robot manipulation tasks are discussed. Programming and performing general and complex tasks where the robot has a direct interaction with a nonspecific environment are optimized. A flexible tool is presented to compute trajectories for any mechanical constrained structure, composed of polyhedral bodies. Its formalism allows to specifiy many kinds of manipulation tasks with constraints. The task representation is made through a kinematic graph which leads to a numerical linear model. This model is treated by a procedure that can solve incompletely specified tasks, or tasks with redundant or incompatible specifications. The method is applied to compute the fine motion of an object in contact with several other objects. The contact description is made in a natural manner, by using relations between geometric features (vertex, edge, face). A methodical treatment of each class of contact allows to quickly calculate good trajectories automatically. How to exploit the same method to perform calibration tasks for the updating of the position of an object in its environment is discussed. An interactive graphical programming system developed to offer a high level description of manipulation tasks and great comfort in driving the robot is described. ESA

**N91-20666*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**A COLLISION DETECTION ALGORITHM FOR TELEROBOTIC ARMS**
Doan Minh Tran (ST Systems Corp., Lanham, MD.) and Maureen OBrien Bartholomew *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 194-200 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

**N91-20667*#** Rice Univ., Houston, TX. Dept. of Electrical and Computer Engineering.
**EXACT AND EXPLICIT OPTIMAL SOLUTIONS FOR TRAJECTORY PLANNING AND CONTROL OF SINGLE-LINK FLEXIBLE-JOINT MANIPULATORS**
Guanrong Chen *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 201-206 (For primary document see N91-20641 12-59)
(Contract N00014-88-K-0127)
Avail: NTIS HC/MF A21 CSCL 09B

**N91-20672*#** Ford Aerospace Corp., Sunnyvale, CA. Artificial Intelligence Group.
**CHALLENGES IN BUILDING INTELLIGENT SYSTEMS FOR SPACE MISSION OPERATIONS**
Wayne Hartman *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 259-263 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

**N91-20682*#** National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
**AN INTELLIGENT ADVISORY SYSTEM FOR PRE-LAUNCH PROCESSING**
Peter A. Engrand and Tami Mitchell *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 331-336 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

**N91-20686*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**THE REAL-TIME CONTROL OF PLANETARY ROVERS THROUGH BEHAVIOR MODIFICATION**
David P. Miller *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 362-366 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

**N91-20687*#** Thomson-CSF, Palo Alto, CA.
**REASONING ABOUT REAL-TIME SYSTEMS WITH TEMPORAL INTERVAL LOGIC CONSTRAINTS ON MULTI-STATE AUTOMATA**
Armen Gabrielian *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 368-374 (For primary document see N91-20641 12-59)
(Contract N00014-89-C-0022)
Avail: NTIS HC/MF A21 CSCL 09B

**N91-20688*#** Inference Corp., El Segundo, CA.
**A FRAMEWORK FOR BUILDING REAL-TIME EXPERT SYSTEMS**
S. Daniel Lee *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 375-382 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

**N91-20692*#** Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
**QUANTITATIVE KNOWLEDGE ACQUISITION FOR EXPERT SYSTEMS**
Brenda L. Belkin and Robert F. Stengel *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 405-413 (For primary document see N91-20641 12-59)
(Contract NGL-31-001-252; DAAG29-84-K-0048)
Avail: NTIS HC/MF A21 CSCL 09B

**N91-20695*#** Air Force Human Resources Lab., Brooks AFB, TX.
**ROSE GARDEN PROMISES OF INTELLIGENT TUTORING SYSTEMS: BLOSSOM OR THORN**
Valerie J. Shute *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 431-438 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

**N91-20697*#** Abacus Programming Corp., Van Nuys, CA.
**THE AI BUS ARCHITECTURE FOR DISTRIBUTED KNOWLEDGE-BASED SYSTEMS**
Roger D. Schultz and Iain Stobie *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 449-454 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 09B

**N91-20706*#** Georgia State Univ., Atlanta. Center for Human-Machine Systems Research.
**ALLY: AN OPERATOR'S ASSOCIATE FOR SATELLITE GROUND CONTROL SYSTEMS**
J. B. Bushman, Christine M. Mitchell, P. M. Jones, and K. S. Rubin *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 499-506 (For primary document see N91-20702 12-59)
(Contract NAS5-28575; NAG2-413)
Avail: NTIS HC/MF A14 CSCL 09B

**N91-20708*#** Georgia State Univ., Atlanta. Center for Human-Machine Systems Research.
**OFMSPERT: AN ARCHITECTURE FOR AN OPERATOR'S ASSOCIATE THAT EVOLVES TO AN INTELLIGENT TUTOR**
Christine M. Mitchell *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 522-526 (For primary document see N91-20702 12-59)
(Grants NAG2-413; NAG5-1044)
Avail: NTIS HC/MF A14 CSCL 09B

**N91-20712*#** Ohio State Univ., Columbus. Cognitive Systems Engineering Lab.
**GUIDANCE FOR HUMAN INTERFACE WITH ARTIFICIAL INTELLIGENCE SYSTEMS**
Scott S. Potter and David D. Woods *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 547-549 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 09B

**N91-20720*#** Miami Univ., Coral Gables, FL. Dept. of Psychology.
**ELECTRONIC COLLABORATION: SOME EFFECTS OF TELECOMMUNICATION MEDIA AND MACHINE INTELLIGENCE ON TEAM PERFORMANCE**
A. Rodney Wellens *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 606-611 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 09B

**N91-20721*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**ISSUES ON COMBINING HUMAN AND NON-HUMAN INTELLIGENCE**
Irving C. Statler and Mary M. Connors *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 612-619 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 09B

## 64 NUMERICAL ANALYSIS

Includes iteration, difference equations, and numerical approximation.

**N91-20830*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**ACCURATE MONOTONE CUBIC INTERPOLATION**
Hung T. Huynh Mar. 1991 63 p
(NASA-TM-103789; E-6066; NAS 1.15:103789) Avail: NTIS HC/MF A04 CSCL 12A

Monotone piecewise cubic interpolants are simple and effective. They are generally third-order accurate, except near strict local extrema where accuracy degenerates to second-order due to the monotonicity constraint. Algorithms for piecewise cubic interpolants, which preserve monotonicity as well as uniform third and fourth-order accuracy are presented. The gain of accuracy is obtained by relaxing the monotonicity constraint in a geometric framework in which the median function plays a crucial role.
Author

**N91-20831#** Rome Air Development Center, Griffiss AFB, NY.
**MULTICHANNEL LINEAR PREDICTION AND ITS ASSOCIATION WITH TRIANGULAR MATRIX DECOMPOSITION Report, Apr. 1989 - May 1990**
James H. Michels Nov. 1990 37 p
(AD-A230052; RADC-TR-90-226) Avail: NTIS HC/MF A03 CSCL 20/6

Much of the existing literature on theory of light scattering from fluctuating media is restricted to either monochromatic incident fields, or to quasimonochromatic incident fields which are spatially coherent over the entire scattering volume. This reprint presents a theory of light scattering from fluctuating media which allows the spectrum and the coherence properties of the incident light to be very general, and which makes less restrictive assumptions about the response of the scattering medium than the usual theories. A fuller version of this work will appear elsewhere.
GRA

**N91-20832#** Carnegie-Mellon Univ., Pittsburgh, PA. Robotics Inst.
**THE 3-D OBJECT POSE DETERMINATION USING COMPLEX EGI**
Sing B. Kang and Katsushi Ikeuchi Oct. 1990 54 p
(Contract F33615-87-C-1499)
(AD-A230112; CMU-RI-TR-90-18) Avail: NTIS HC/MF A04 CSCL 12/9

This report describes a new method based on the Extended Gaussian Image (EGI) which can be used to determine the pose of a 3-D object. In this scheme, the weight associated with each outward surface normal is a complex weight. The normal distance of the surface from the predefined origin is encoded as the phase of the weight while the magnitude of the weight is the visible area of the surface. This approach decouples the orientation and translation determination into two distinct least-squares problems. Experiments involving synthetic data of two polyhedral and two smooth objects indicate the feasibility of this method. The best results are 4.7 and 1.5 percent (total distance error) for the polyhedral and smooth objects respectively. The figures are quoted in terms of percentages of the maximum allowable displacement. Experiments using real range data for the two smooth objects yield good results, with total translation errors as low as 2.6 percent.
GRA

**N91-20833#** Massachusetts Inst. of Tech., Cambridge. Lab. for Computer Science.
**RESULTS IN COMPUTATIONAL GEOMETRY: GEOMETRIC EMBEDDINGS AND QUERY-RETRIEVAL PROBLEMS**
Mark D. Hansen Nov. 1990 91 p
(Contract N00014-89-J-1988)
(AD-A230380; MIT/LCS/TR-492) Avail: NTIS HC/MF A05 CSCL 12/1

Many fundamental questions in computational geometry arise from the consideration of distributions of points in euclidean space. Two important areas of computational geometry are explored in this setting: geometric embeddings and query-retrieval problems. Each area is addressed in a separate part of the thesis. Part 1 examines the geometric embedding problem for many of the graphs which are important in the study of parallel computation. Part 2 examines query-retrieval problems concerning distributions of points in euclidean space. In this part, a new technique is described for solving a variety of query-retrieval problems in optimal time with

optimal or near optimal space. The compaction technique incorporates planar separators, filtering search, and the probabilistic method for discrepancy problems. GRA

**N91-20834#** Maryland Univ., College Park.
**APPLICATIONS OF OPERATOR THEORY TO MAXIMUM ENTROPY PROBLEMS Final Report, 15 Jun. 1987 - 15 Oct. 1990**
Robert L. Ellis, Israel Gohberg, and David C. Lay 12 Oct. 1990 6 p
(Grant AF-AFOSR-0287-87; AF Proj. 2304)
(AD-A230417; AFOSR-90-1211TR) Avail: NTIS HC/MF A02 CSCL 12/1

This project was concerned with problems in operator theory and matrix theory that underlie the maximum entropy principle in signal processing and systems theory. Two papers were completed that generalize this principle to a wide class of indefinite hermitian matrices. Three new papers give a thorough study of rank-preserving extensions of band matrices. Factorization theorems are obtained for wide classes of Toeplitz and Hankel matrices, and connections are given to the Kalman partial realization problems in signal processing. Applications are also given to signal processing when the power spectrum consists of a set of pure line spectra. In another paper, new work on orthogonal polynomials and the Gohberg-Semencul formula for the inverse of a Toeplitz matrix was completed. Three new papers generalize for rational matrix functions a number of well known interpolation problems for scalar functions. A new approach to tangential interpolation problems is presented, and applications are given to sensitivity minimization in control theory. GRA

**N91-20835#** Dayton Univ., OH.
**IMAGE QUALITY METRICS AND APPLICATION OF THE SQUARE ROOT INTEGRAL (SQRI) METRIC: AN OVERVIEW Final Report, Jan. 1989 - Jun. 1990**
Ronald J. Evans Nov. 1990 69 p
(Contract F33615-90-C-0005)
(AD-A229753; AFHRL-TR-90-56) Avail: NTIS HC/MF A04 CSCL 20/5

The purpose of this report was to present an overview of image quality metrics and evaluate the performance of the Modulation Transformer Function Area (MTFA) and the Square Root Integral (SQRI) metrics on displays used at the Air Force Human Resources Laboratory (AFHRL). While the MFTA, as indicated by its name, correlates highly with the display modulation transfer function area, the SQRI, developed by Barten (1987), integrates display luminance, contrast as measured through the modulation transfer function, and resolution into a single measure in a different fashion. The scalar results obtained from the metrics act as an image of quality for the display devise. Results of the analyses showed that (1) image quality metrics lacks the ability to incorproate the relative importance of display luminance; (2) the J measure from the SQRI metric emphasizes low spatial frequency information (less than 5 cycles/degrees) relative to high spatial frequencies; (3) only on of the two measures developed by Barten, the J index, yielded unambiguous results; (4) small variability in the low spatial frequency of the MF4TF could cause large changes in the resulting SQRI image quality measures; and (5) the concept of the display modulation depth curve (or display MTF) employed in image quality metrics is ambiguous and requires some form of further standardization. GRA

**N91-20836#** Applied Research Lab., State College, PA.
**EXPANSION OF INTEGRAL EQUATIONS ARISING IN SCATTERING THEORY**
S. T. McDaniel 2 Mar. 1990 22 p
(AD-A229830; ARL/PSU/TM-90-59) Avail: NTIS HC/MF A03 CSCL 12/1

The key to solving a general scattering problem is first to obtain a solution for the relevant field parameter evaluated on the scattering surface. For all but very simple cases, which can be treated numerically, this entails an approximation which thence limits the region of applicability of the result obtained. Three different formulations were considered of the boundary integral equation for plane wave incidence on a periodic pressure release surface. In the low frequency limit, the three equations yield different results. Only Uretsky's integral equation yields physically acceptable reflection coefficients and these are identical to those obtained using the Rayleigh or small wave height approximation. Whereas the Rayleigh approximation is in good agreement with exact solutions for scattering at low frequencies and grazing angles, when the frequency or grazing angle is significantly increased, this approximation yields scattering strength predictions considerably higher than those experimentally observed. It appears that Uretsky's integral equation is the only viable starting point for developing a general scattering theory applicable over a greater range of parameters. GRA

**N91-20837#** Pennsylvania State Univ., University Park. Dept. of Computer Science.
**LARGE SPARSE STABLE MATRIX COMPUTATIONS Final Report, 1 Apr. 1988 - 30 Jun. 1990**
Alex Pothen and Jesse L. Barlow 30 Oct. 1990 9 p
(Grant AF-AFOSR-0161-88; AF Proj. 2304)
(AD-A229837; AFOSR-90-1156TR) Avail: NTIS HC/MF A02 CSCL 12/1

The project proposal discussed two problem areas: (1) The solution of large sparse of linear equations; and (2) The solution of sparse least squares problems. Progress is reported in both of these areas and in a third area, the solution of the algebraic eigenvalue problem. The progress in solving systems of linear equations included an algorithm for computing ordering for efficiently factoring sparse symmetric, positive definite systems in parallel. Progress was also made in computing the ordering itself in parallel. Other progress included a method for handling singular blocks in a one-way dissection ordering and an error analysis of Gaussian elimination in unnormalized arithmetic. For linear least squares problems, an efficient reliable method was developed for detecting the rank of a sparse matrix without column exhanges. The method used a static data structure. Methods were also analyzed and compared for computing sparse and dense QR factorizations on message passing architectures. On the algebraic eigenvalue problem, long standing open questions were resolved on relative perturbation bounds on certain diagonally dominant eigenvalue problems. GRA

**N91-20838#** Indiana Univ., Indianapolis. Dept. of Psychology.
**EVALUATION OF BOOTSTRAP AND PARAMETRIC PERCENTILE CONTRASTS. VOLUME 1: SPLITS ANALYSIS: A METHOD FOR NONCENTRAL TENDENCY COMPARISONS Final Report, 1 Mar. - 31 Dec. 1990**
Jeffrey L. Rasmussen 25 Oct. 1990 14 p
(Grant AF-AFOSR-0190-90; AF Proj. 2304)
(AD-A230506; AFOSR-90-1198TR-Vol-1) Avail: NTIS HC/MF A03 CSCL 12/1

In some instances group comparisons in terms of upper or lower portions of the score distributions are more informative than comparisons of central tendency. These comparisons can be done by carrying out a split on the data prior to an analysis of variance (ANOVA). The resulting test statistic from ANOVA is not distributed as an F ration however, and requires evaluation for significance relative to an empirical Monte-Carlo distribution. An example and computer program are presented. GRA

**N91-20839#** Naval Surface Warfare Center, Dahlgren, VA.
**SIGNIFICANT DIGIT COMPUTATION OF THE ELLIPTICAL COVERAGE FUNCTION Final Report**
Armido R. Didonato Sep. 1990 40 p
(AD-A230523; NAVSWC-TR-90-513) Avail: NTIS HC/MF A03 CSCL 12/5

An algorithm is given for evaluating the elliptical coverage function. A FORTRAN subroutine PKILL supplies the function to at least six significant digits over a large range of the input parameters when the precision is not restricted by inherent error. Several new procedures are used. An algorithm is also given for the supporting function erf(x + h) - erf(x - h). A FORTRAN function

AERF supplies this function to 12 significant digits. Listings of transportable FORTRAN subprograms PKILL and AERF are included. GRA

**N91-20840#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**ROBUSTNESS OF HARDY SPACE WITH FINITE 2-NORM AND HARDY SPACE WITH FINITE INFINITY-NORM M.S. Thesis**
Steven R. Kolbow Dec. 1990 117 p
(AD-A230524; AFIT/GAE/ENY/90D-13) Avail: NTIS HC/MF A06 CSCL 16/2

This work follows Capt. R. L. Riddle's 1989 thesis (ADA216147) which compared conventional, H2 (Hardy space with finite 2-norm) and H infinity (Hardy space with finite infinity norm) controlled guided missiles in simulated flyouts against an airborne target. The simulation results did not clearly demonstrate the H2 and H infinity controller advantages. In this study the missile model and simulation were refined. In addition to simulation runs, performance, noise attenuation, and mu (structural singular value) robustness analyses were conducted. Results showed areas where improvement was needed in the H2 and H infinity controllers used in the study. An H2 and H infinity controller redesign is recommended using the mu synthesis design technique. Additional simulation runs are also recommended to examine whether the improved controllers reduce miss distances. GRA

**N91-20841#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**AN EVOLUTION OPERATOR SOLUTION FOR A NONLINEAR BEAM EQUATION Ph.D. Thesis**
Carl E. Crockett Dec. 1990 155 p
(AD-A230533; AFIT/DS/ENC/90-2) Avail: NTIS HC/MF A08 CSCL 12/1

A nonlinear partial differential equation, motivated by the transverse vibration of a beam, is shown to have a unique solution. The existence theory, which is in the setting of semigroups and evolution operators, is a composite and synthesis of theorems of Kato. The formulation of the problem and the verification that the formulation leads to a solution are new. The introductory chapter provides background on the topic generally. Then detailed formulations are provided for the constant coefficient case. Nonautonomous cases are described. The general theorem is presented. A more general case is considered. Namely, Kelvin Voigt damping with a coefficient which depends on the solution. This introduces a nonlinearity to the problem which makes it of the form frequently called quasilinear. This is a stronger form of nonlinearity than semilinear. Results of a numerical example are presented. GRA

**N91-20842#** California Univ., Santa Barbara. Center for Computational Sciences and Engineering.
**STABILITY ANALYSIS OF FINITE DIFFERENCE APPROXIMATIONS TO HYPERBOLIC SYSTEMS AND PROBLEMS IN APPLIED AND COMPUTATIONAL MATRIX AND OPERATOR THEORY Final Report, 1 May 1988 - 30 Nov. 1990**
Moshe Goldberg and Marvin Marcus 7 Dec. 1990 83 p
(Grant AF-AFOSR-0175-88; AF Proj. 2304)
(AD-A230543; AFOSR-90-1221TR) Avail: NTIS HC/MF A05 CSCL 12/1

This report describes research in the following areas: (1) convenient stability criteria for difference approximations to hyperbolic initial-boundary value problems; (2) multiplicativity and stability of matrix and operator norms; (3) hadamard products and powers; (4) inequalities for tensors; (5) inequalities for generalized matrix functions; (6) inequalities for eigenvalues and singular values; (7) distance matrices; (8) numerical range; and (9) determinants of sums. GRA

**N91-20843#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**A NUMERICAL INVESTIGATION OF THE SERIES REVERSION/INVERSION AND SERIES REVERSION OF LAMBERT'S TIME FUNCTION M.S. Thesis**
Michael P. Ward Dec. 1990 88 p
(AD-A230545; AFIT/GA/ENY/90D-14) Avail: NTIS HC/MF A05 CSCL 12/1

An expression for the semi-major axis as a function of time may be determined by performing a series reversion and inversion of Lambert's Time Function. Since the resulting series contains a singularity, it is desirable to perform only a reversion on the original series to obtain an expression for the inverse of the semi-major axis. Using a Lagrange expansion to obtain the coefficients for this series is very computer intensive. Therefore, alternative methods are presented. Also, each series was expanded into a continued fraction which provided greater accuracy than the series using the same number of coefficients. The accuracy was found to be dependent upon the number of series coefficients used, the transfer time, and the transfer angle. GRA

**N91-20844#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**MODELLING AND ANALYSIS OF KERNEL FUNCTION AND DEVELOPMENT OF EQUIVALENT THEODORSEN FUNCTION FOR THREE-DIMENSIONAL AEROELASTIC ANALYSIS M.S. Thesis**
John K. Ryder Dec. 1990 129 p
(AD-A230628; AFIT/GAE/ENY/90D-25) Avail: NTIS HC/MF A07 CSCL 20/4

A fractional calculus model is developed for the kernal function under incompressible subsonic flow conditions for rectangular planform airfoils with small aspect ratio. A model valid for restricted regions of the kernel function for compressible subsonic flow conditions is also developed. Additionally, a method for numerically solving the pressure-downwash integral equation for rectangular planform wings of aspect ratio two through ten in incompressible flow is developed. An equivalent Theodorsen function for 3-D unsteady flow is developed, enabling the use of simpler 2-D aeroelastic equations of motion to fully capture the more complicated 3-D effects. GRA

**N91-20845#** Wisconsin Univ., Madison. Center for Mathematical Sciences.
**SPLINE FUNCTIONS AND SURFACES Final Report, 23 May 1987 - 28 Sep. 1990**
Carl DeBoor 1990 8 p
(Contract DAAL03-87-K-0030)
(AD-A230651; ARO-24074.15-MA) Avail: NTIS HC/MF A02 CSCL 12/1

The goal was to study the use of (smooth) piecewise polynomial spaces for the approximation of functions in one and, preferably, in several variables and find a better understanding of how well one can approximate from specific spaces, for specific schemes for approximation, including good bases for such spaces. The goal was also to make inroads on the problem of extending techniques for curve fitting by smoothly patched curves to surface interpolation. Progress was made on these questions and on two related but unanticipated projects: (1) a monograph on box splines (to make available in easily accessible form the many results on box splines obtained by us and others since their introduction by us ten years ago); and (2) what now looks like the right approach to polynomial interpolation in several variables. GRA

**N91-20846#** Stanford Univ., CA. Dept. of Statistics.
**THEORY AND APPLICATIONS OF ELLIPTICALLY CONTOURED AND RELATED DISTRIBUTIONS**
T. W. Anderson and Kai-Tai Fang Sep. 1990 33 p
(Contract DAAL03-89-K-0033)
(AD-A230672; TR-24; ARO-26394.3-MA) Avail: NTIS HC/MF A03 CSCL 12/3

A random vector X is said to have elliptically contoured distribution if it has the distribution of mu + AY, where mu is a

constant matrix, and the random vector Y has a spherical distribution: Y is distributed as QY for every orthogonal matrix Q. This paper surveys recent work on distribution theory and statistical inference for elliptically contoured distributions. It emphasizes the contributions of the authors and of the students and associates of the second author; it gives a picture of this area of multivariate analysis that is particularly active in the People's Republic of China. Included are classifications of elliptically contoured and related distributions, distributions of quadratic forms, estimation of parameters, testing hypotheses, and applications. Since the normal distribution is in the class, the properties of elliptically contoured distributions are similar to those of the normal distribution. GRA

**N91-20847#** Cranfield Inst. of Tech., Bedford (England). Coll. of Aeronautics.
**TVD REGIONS FOR THE WEIGHTED AVERAGE FLUX (WAF) METHOD AS APPLIED TO A MODEL HYPERBOLIC CONSERVATION LAW**
E. F. Toro Jun. 1989 40 p
(Cranfield-Aero-8907; ISBN-1-871564-09-3; ETN-91-99011)
Avail: NTIS HC/MF A03; Cranfield Inst. of Technology, Coll. of Aeronautics, Cranfield, Bedford MK 43 0AL, England, HC 8 sterling pounds

Oscillation free versions of the WAF method for the model equation u(sub t) + au(sub x) = 0 are presented. Two approaches, Courant number amplification and flux, or weight, limiting, are detailed. Extended TVD (Total Variation Deminishing) regions are derived and amplifying/limiting functions are constructed. Numerical experiments on the model equation are performed. A relationship between amplifiers and limiters is established which is useful when designing amplifying functions. The analysis is applicable to the linear model equation but empirical results obtained for nonlinear systems of hyperbolic conservation laws are satisfactory. ESA

**N91-20713*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**DEVELOPMENT OF BIOMECHANICAL MODELS FOR HUMAN FACTORS EVALUATIONS**
Barbara Woolford, Abhilash Pandya, and James Maida (Lockheed Engineering and Sciences Co., Houston, TX.) *In its* Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 552-556 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 12A

# 65 STATISTICS AND PROBABILITY

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

**N91-20848#** Forest Service, New Orleans, LA. Southern Forest Experiment Station.
**THEORY AND DERIVATION FOR WEIBULL PARAMETER PROBABILITY WEIGHTED MOMENT ESTIMATORS**
J. M. Grender, T. R. Dell, and R. M. Reich Nov. 1990 21 p
Prepared in cooperation with Colorado State Univ., Fort Collins
(PB91-124495; FSRP-SO-260) Avail: NTIS HC/MF A03 CSCL 12A

Probability weighted moments (PWM's) provide a promising new method of parameter estimation for distributions that can be expressed explicitly in inverse form. The Weibull distribution is one such distribution whose inverse is analytically defined. As a result, the Weibull parameters can be written directly as functions of these moments. Probability weighted moments can be applied when either the right or left tail of the distribution demands more attention than does the other side of the distribution. Details on the PWM theory, including original derivation of the right-weighted moments for any distribution and specifically for the Weibull distribution are provided. An unbiased estimator for the right-weighted PWM is also derived so that one can compute the Weibull parameter estimator. A computer program was developed for forest tree distribution data using PWM's with the Weibull distribution. The moments are computed so that more emphasis is placed on the right side of the distribution or on the larger observations. Such an emphasis is meaningful in forestry as the larger trees are generally more important. Author

**N91-20849#** Naval Underwater Systems Center, New London, CT.
**ALIAS-FREE SMOOTHED WIGNER DISTRIBUTION FUNCTION FOR DISCRETE-TIME SAMPLES Technical Progress Report**
Albert H. Nuttall 9 Oct. 1990 45 p
(AD-A229987; NUSC-TR-8785) Avail: NTIS HC/MF A03 CSCL 12/3

An alias-free Wigner distribution function (WDF), for a time waveform s(t) limited to total frequency extent F, is available if the time sampling increment delta is less than 1/F. Furthermore, the WDF can be efficiently numerically evaluated via fast Fourier transform (FFT) procedures if the FFT size N is greater than 2T/delta, where T is the effective duration of s(t). However, in order to suppress the undesired inherent oscillating interference terms in the WDF, it is necessary to smooth the WDF, or equivalently, weight the complex ambiguity function. This smoothing operation cannot be accomplished without the penalty in terms of sampling increment delta and FFT size N. In particular, if the smearings in the time and frequency domains of the WDF are 2/B and 2/D, respectively, the new tighter requirements are delta less than (1/CF + 2/D), and N greater than (2T/Delta) + 4/B(Delta). GRA

**N91-20850#** Ballistic Research Labs., Aberdeen Proving Ground, MD.
**HIGH-RESOLUTION VULNERABILITY METHODS AND APPLICATIONS Final Report, Sep. 1989 - Oct. 1990**
Paul H. Deitz and Aivars Ozolins Nov. 1990 37 p
(AD-A230036; BRL-MR-3876) Avail: NTIS HC/MF A03 CSCL 19/10

Over the past five years, considerable attention has been focussed in the Army on the requirements of vulnerability modeling. Both applicability of extant models to an expanding number of users and their accuracy have received scrutiny. In response to needs for improved capability, the Ballistic Research Laboratory (BRL) has developed a high-resolution stochastic vulnerability model. In this paper, the core logic structure used to represent target functioning is presented. In addition, the means for introducing stochastic damage mechanisms are described. GRA

**N91-20851#** Princeton Univ., NJ. Information Sciences and Systems Lab.
**QUICKEST DETECTION PROCEDURES AND TRANSIENT SIGNAL DETECTION Technical Report, Sep. 1988 - Jun. 1990**
Bruce Broder and Stuart Schwartz Nov. 1990 195 p
(Contract N00014-81-K-0162)
(AD-A230068; TR-21) Avail: NTIS HC/MF A09 CSCL 12/3

This dissertation focuses on sequential decision procedures to detect changes in the statistical model of an observed random process when these changes can occur at unknown times. In the disorder problem, the samples are drawn according to one statistical model until some unknown time after which all the samples correspond to a second model. In the transient problem, the model then reverts back to the first one after some finite time. A detection procedure known as Page's test is investigated for the quick detection of the disorder. A simple asymptotic measure is defined and an analytic formula is developed which can be useful in evaluating the performance of Page's test in various situations. By examining the local performance, it is found that the performance is directly related to the efficacy in the binary hypothesis testing situation, allowing the wealth of results in that context to be transferred to Page's test. Because Page's test appears to detect changes in distribution quickly, it is a candidate for transient signal detection. GRA

**N91-20852#** Test Wing (3246th), Eglin AFB, FL. Electronic Warfare Test Div.
**TABLES OF CONFIDENCE LIMITS FOR PROPORTIONS**

Robert B. Faust Sep. 1990 410 p
(AD-A230079; AFDTC-TR-90-48) Avail: NTIS HC/MF A18 CSCL 12/3

This reference document contains tables of confidence limits for proportions for all sample size from 1 through 100. For sample sizes 105 through 200, tables are provided at intervals of five. Tables are also provided for sample sizes of 500 and 1000. When a sample size is not included in one of the tables, a method is provided for interpolating between tabled values to obtain accurate confidence limits for any sample size less than 1000. Confidence limits have been computed for the most frequently used confidence levels; i.g., 90, 95, and 99 percent. Data are complied into three tables. One consists of two-sided confidence limits, one consists of one-sided lower confidence limits, and the third consists of one-sided upper confidence limits. The confidence limits are given to three decimal places for samples of size 195 and less. Samples of size 200, 500, and 1000 are given to four decimal places to improve the accuracy of interpolations. GRA

**N91-20853#** Scripps Institution of Oceanography, La Jolla, CA. Marine Physical Lab.
**COHERENCE OF TRANSIENTS**
Amos A. Dotan and William S. Hodgkiss Sep. 1990 186 p
(Contract N00014-89-J-1036)
(AD-A230168; MPL-U-34/90; MPL-TM-425) Avail: NTIS HC/MF A09 CSCL 17/11

This technical report analyzes the performance of various methods of Squared Magnitude Coherency (SMC) estimation when the available data is very short. Three methods of Squared Magnitude Coherency estimation were examined. The first, Coherency estimation using the periodogram and a FFT (the frequency domain). The second, Fitting an AR model to the process, estimating its coefficients, and calculating the SMC from the coefficients (the time domain analysis). The third method is a direct coherency estimation via constrained least squares linear prediction. For a short data the SMC estimation using the time domain method has a large bias error, and a large confidence interval. The other two methods have reasonable performance for short data. Most of the previous work that calculated the SMC estimation confidence interval, assumed that to the estimated SMC is Gaussian distributed (Bendat & Piersol, Brockwell and Davis). Simulation results show that this assumption holds only for SMC values between 0.3 to 0.8, for long data as well as short data. Simulation results reveal that as soon as the number of samples is such that the law of large numbers holds (n greater than or equal to 40), all the expressions of the estimated SMC density function developed by Carter et al. and Sakai et al. still hold. GRA

**N91-20854#** Naval Ocean Systems Center, San Diego, CA.
**CRAMER-RAO BOUND, MUSIC, AND MAXIMUM LIKELIHOOD. EFFECTS OF TEMPORAL PHASE DIFFERENCE Final Report**
C. V. Tran Nov. 1990 51 p
(AD-A230259; NOSC-TR-1373) Avail: NTIS HC/MF A04 CSCL 12/1

We derived closed-form expressions for the Cramer-Rao Bound, MUSIC, and maximum likelihood (ML) asymptotic variances corresponding to the two-source direction-of-arrival estimation where sources were modeled as deterministic signals impinging on a uniform linear array. The choice of the center of the array as the coordinate reference resulted in compact expressions that greatly facilitated our study of effects of temporal phase difference (correlation phase) of the two sources on asymptotic variances of estimation error. These effects were shown to be intensified when the two signals were closely spaced and/or when their normalized correlation magnitude was high. Numerical examples obtained from specializing general formulas agreed with our results. GRA

**N91-20855#** Naval Postgraduate School, Monterey, CA.
**REGRESSION ANALYSIS OF HIERARCHICAL POISSON-LIKE EVENT RATE DATA: SUPER-POPULATION MODEL EFFECT ON PREDICTIONS**
Donald P. Gaver, Patricia A. Jacobs, and I. G. OMuircheartaigh Aug. 1990 33 p
(AD-A230297; NPS55-90-19) Avail: NTIS HC/MF A03 CSCL 12/3

This paper studies prediction of future failure (rates) by hierarchical empirical Bayes (EB) Poisson regression methodologies. Both a gamma distributed super-population as well as a more robust (long-tailed) log student-t super-population are considered. Simulation results are reported concerning predicted Poisson rates. The results tentatively suggest that a hierarchical model with gamma super-population can effectively adapt to data coming from a log-Student-t-super-population particularly if the additional computation involved with estimation for the log-Student-t hierarchical model is burdensome. GRA

**N91-20856#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**IMPLEMENTATION OF THE MODIFIED MONTE CARLO TECHNIQUE USING IMPORTANCE SAMPLING ON THE BLOCK ORIENTED SYSTEM SIMULATOR M.S. Thesis**
John B. Bennett Dec. 1990 73 p
(AD-A230500; AFIT/GE/ENG/90D-03) Avail: NTIS HC/MF A04 CSCL 25/5

The purpose of this thesis was to implement the Modified Monte Carlo technique using Importance Sampling on the Block Oriented System Simulator (BOSS). Computer simulation techniques of communications systems were reviewed. Next, conventional Monte Carlo techniques and Modified Monte Carlo techniques using Importance Sampling were reviewed. Models of Binary Phase Shift Keying (BPSK) systems using both Monte Carlo techniques were implemented and simulated. Reasons for the model using Importance Sampling not working correctly are postulated. The Monte Carlo technique is a method of ensuring the an inherently infinite procedure, such as determining system bit error rate (BER), can be determined within an appropriate accuracy and a confidence range after a set number of samples. Conventional Monte Carlo requires a certain number of samples to be generated to determine a certain BER. This number of samples results in an estimated BER in the range of 0.5 to 2.0 of the true BER. The number of samples required using conventional Monte Carlo techniques can result in unacceptable simulation times for low probability events. Importance sampling is a method of reducing the number of samples required to determine an estimated BER with the same accuracy and confidence as conventional Monte Carlo. GRA

# 66 SYSTEMS ANALYSIS

Includes mathematical modeling; network analysis; and operations research.

**N91-20857*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**TEST AND EVALUATION OF THE GENERALIZED GATE LOGIC SYSTEM SIMULATOR**
Paul S. Miner Washington Apr. 1991 20 p
(NASA-TM-4251; L-16822; NAS 1.15:4251) Avail: NTIS HC/MF A03 CSCL 12B

The results of the initial testing of the Generalized Gate Level Logic Simulator (GGLOSS) are discussed. The simulator is a special purpose fault simulator designed to assist in the analysis of the effects of random hardware failures on fault tolerant digital computer systems. The testing of the simulator covers two main areas. First, the simulation results are compared with data obtained by monitoring the behavior of hardware. The circuit used for these comparisons is an incomplete microprocessor design based upon the MIL-STD-1750A Instruction Set Architecture. In the second area of testing, current simulation results are compared with experimental data obtained using precursors of the current tool. In each case, a portion of the earlier experiment is confirmed. The new results are then viewed from a different perspective in

order to evaluate the usefulness of this simulation strategy.
Author

**N91-20858#** Los Alamos National Lab., NM.
**INTERACTION OF STRATEGIC DEFENSES WITH CRISIS STABILITY**
G. H. Canavan Mar. 1991 26 p
(Contract W-7405-eng-36)
(DE91-008480; LA-11920-MS) Avail: NTIS HC/MF A03

Retaliatory deterrence is now carried primarily by Submarine Launched Ballistic Missiles (SLBMs). START would shift that toward aircraft. Moderate defenses would shift retaliation strongly toward aircraft. Combined boost- and midcourse defenses would increase stability. Mutual reductions of heavy ICBMs have little impact in the absence of defenses. It appears preferable to defend current missiles in place. Unilateral deployments of defense leave crisis indices unchanged while reducing the number of weapons delivered. One-sided reductions in conjunction with defenses produce intermediate indices. Interactive reduction of defense suppression could reduce penetration to marginal levels. Coupling between second strike and target set could be resolved by altering objectives or the target set. DOE

**N91-20859#** Los Alamos National Lab., NM.
**INTERACTION OF STRATEGIC DEFENSES WITH CRISIS STABILITY**
G. H. Canavan Mar. 1991 58 p
(Contract W-7405-eng-36)
(DE91-009004; LA-11870-MS) Avail: NTIS HC/MF A04

Crisis stability indices calculated for two-sided strategic interactions are used to discuss the impact of boost and midcourse defenses. They largely suppress missiles, leaving bombers and cruise missiles to deliver the bulk of restrikes. Boost-phase defenses are able to attrit missile attacks, but lack the preferentiality needed to defend specific targets. Midcourse layers could protect a significant fraction of forces; combined defenses could defend more. Results are sensitive to decoys and target sets. DOE

**N91-20670*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**ADVANCED AUTOMATION IN SPACE SHUTTLE MISSION CONTROL**
Troy A. Heindel, Arthur N. Rasmussen, and Robert Z. McFarland (Unisys Corp., Houston, TX.) *In its* Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 236-243 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 12B

**N91-20673*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**USER INTERFACE ISSUES IN SUPPORTING HUMAN-COMPUTER INTEGRATED SCHEDULING**
Lynne P. Cooper and Eric W. Biefeld *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 268-274 Sponsored in part by DoD (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 12B

**N91-20674*#** Boeing Computer Services Co., Huntsville, AL. Artificial Intelligence Center.
**ARCHITECTURE FOR SPACECRAFT OPERATIONS PLANNING**
William S. Davis *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 275-278 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 12B

**N91-20725*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**ENVIRONET: AN ONLINE ENVIRONMENTAL INTERACTIONS RESOURCE**
Michael Lauriente *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 668-673 Sponsored by NASA, Washington; AFGL; and AFSC (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 12B

# 67 THEORETICAL MATHEMATICS

Includes topology and number theory.

No abstracts in this category.

# 70 PHYSICS (GENERAL)

For precision time and time interval (PTTI) see *35 Instrumentation and Photography;* for geophysics, astrophysics or solar physics see *46 Geophysics, 90 Astrophysics,* or *92 Solar Physics.*

**N91-20860#** Pittsburgh Univ., PA. Learning Research and Development Center.
**THE CONTENT OF PHYSICS SELF-EXPLANATIONS Technical Report No. 12, Jul. 1987 - Mar. 1989**
Michelene T. Chi and Kurt A. VanLehn 22 Oct. 1990 64 p
(Contracts N00014-84-K-0542; N00014-85-C-0688; NR Proj. RR0-4206)
(AD-A229737) Avail: NTIS HC/MF A04 CSCL 05/6

Several earlier studies have found the amount learned while studying worked-out examples is proportional to the number of self-explanations generated while studying examples. A self-explanation is a comment about an example statement that contains domain-relevant information over and above what was stated in the example line itself. This article analyzes the specific content of self-explanations generated by students while studying physics examples. In particular, the content is analyzed into pieces of constituent knowledge that were used in the comments. These were further analyzed in order to trace the source of knowledge from which self-explanations. The first is deduction from knowledge acquired earlier while reading the text part of the chapter, usually by simply instantiating a general principle, concept, or procedure with information in the current example statements. Such construction of the content of the example statements yield new general knowledge that helps complete the students' otherwise incomplete understanding of the domain principles and concepts. The relevance of this research for instruction and models of explanation-based learning is discussed. GRA

**N91-20861#** Ecole Nationale Superieure des Telecommunications, Paris (France). Groupe Image.
**A NEW APPROACH TOWARDS THE CRITICAL PROPERTIES OF THE ISING MODEL [UNE NOUVELLE APPROCHE DES PROPRIETES CRITIQUES DU MODEL D'ISING]**
Marc Sigelle Oct. 1990 9 p In FRENCH
(TELECOM-90-C-005; ISSN-0751-1337; ETN-91-98898) Avail: NTIS HC/MF A02

A new approach towards the Ising model is presented. The model is useful in statistical physics (as in the study of ferromagnetism) as well as in the Markov field theory used in image processing. Transition phase temperature calculation is another important application of the model. The calculation of the transition phase temperature is however particularly complex. The critical properties of the Ising model are presented such that calculation of transition phase temperature is greatly simplified.
ESA

**N91-20862#** Syracuse Univ., NY. Dept. of Physics.
**A 1.5 TO 4 KELVIN DETACHABLE COLD-SAMPLE TRANSFER SYSTEM: APPLICATION TO INERTIALLY CONFINED FUSION WITH SPIN-POLARIZED HYDROGENS FUELS**

N. Alexander, J. Barden, Q. Fan, and A. Honig 1990 32 p
(Contracts DE-FG03-91ER-18862; DE-FC03-85DP-40200; DE-FG03-90SF-18437)
(DE91-007763; DOE/ER-18862/2) Avail: NTIS HC/MF A03

A compact cold-transfer apparatus for engaging and retrieving samples at liquid helium temperatures (1.5 to 4 K), maintaining the samples at such temperatures for periods of hours, and subsequently inserting them in diverse apparatuses followed by disengagement, is described. The properties of several thermal radiation-insulating shrouds, necessary for very low sample temperatures, are presented. The immediate intended application is transportable target-shells containing highly spin-polarized deuterons in solid HD or D(2) for inertially confined fusion (ICF) experiments. The system is also valuable for unpolarized high-density fusion fuels, as well as for other applications which are discussed. DOE

# 71 ACOUSTICS

Includes sound generation, transmission and attenuation. For noise pollution see *45 Environmental Pollution.*

**N91-20863*#** Florida Atlantic Univ., Boca Raton. Dept. of Ocean Engineering.
**PARAMETRIC AND EXPERIMENTAL ANALYSIS USING A POWER FLOW APPROACH Semiannual Report No. 3**
J. M. Cuschieri Feb. 1990 39 p
(Grant NAG1-685)
(NASA-CR-181990; NAS 1.26:181990) Avail: NTIS HC/MF A03 CSCL 20A

A structural power flow approach for the analysis of structure-borne transmission of vibrations is used to analyze the influence of structural parameters on transmitted power. The parametric analysis is also performed using the Statistical Energy Analysis approach and the results are compared with those obtained using the power flow approach. The advantages of structural power flow analysis are demonstrated by comparing the type of results that are obtained by the two analytical methods. Also, to demonstrate that the power flow results represent a direct physical parameter that can be measured on a typical structure, an experimental study of structural power flow is presented. This experimental study presents results for an L shaped beam for which an available solution was already obtained. Various methods to measure vibrational power flow are compared to study their advantages and disadvantages. Author

**N91-20864#** Aerospace Medical Research Labs., Wright-Patterson AFB, OH.
**LOCALIZATION PERFORMANCE WITH SYNTHESIZED DIRECTIONAL AUDIO Interim Report, Jan. - Sep. 1989**
Jeffrey R. Agnew, Valencia German, Gloria L. Calhoun, and Mark A. Ericson Jul. 1990 72 p
(AD-A230316; AAMRL-TR-90-025) Avail: NTIS HC/MF A04 CSCL 20/1

This report summarizes three studies designed to measure and compare the ability of subjects to localize sounds in azimuth, via headphones, generated by two prototype auditory localization cue synthesizers. In the first study, performance differences were found between the two synthesizers in certain areas of the azimuth plane. Additionally, the design of a synthesizer (e.g., resolution and interpolating between head-related transfer functions (HRTF's)) can impact the perceived direction of the acoustic signals. Previous research with directional audio suggests that the veridicality of 3-D auditory displays could be optimized if individualized HRTF's are employed to synthesize the virtual sound sources, particularly in elevation. However, data from this experiment suggest that this design requirement can be relaxed, especially if only azimuth information is to be conveyed by the localization synthesizer. In the second study, two response methods for measuring localization performance were evaluated. No performance differences were found when subjects either verbally reported angular estimates or pointed to a circle to indicate the perceived direction of the target stimuli. In the third study, performance was impacted by manipulating the bandwidth of the acoustic signal and head movement. Author

**N91-20865#** Texas Univ., Austin. Dept. of Mechanical Engineering.
**PROBLEMS IN NONLINEAR ACOUSTICS: PULSED FINITE AMPLITUDE SOUND BEAMS, NONLINEAR ACOUSTIC WAVE PROPAGATION IN A LIQUID LAYER, NONLINEAR EFFECTS IN ASYMMETRIC CYLINDRICAL SOUND BEAMS, EFFECTS OF ABSORPTION ON THE INTERACTION OF SOUND BEAMS, AND PARAMETRIC RECEIVING ARRAYS Annual Summary Report No. 2, 1 Aug. 1989 - 30 Sep. 1990**
Mark F. Hamilton 7 Dec. 1990 20 p
(Contract N00014-89-J-1003)
(AD-A230327) Avail: NTIS HC/MF A03 CSCL 20/1

This report discusses five projects all of which involve basic theoretical research in nonlinear acoustics: (1) pulsed finite amplitude sound beams are studied with a recently developed time domain computer algorithm that solves the KZK nonlinear parabolic wave equation; (2) nonlinear acoustic wave propagation in a liquid layer is a study of harmonic generation and acoustic soliton information in a liquid between a rigid and a free surface; (3) nonlinear effects in asymmetric cylindrical sound beams is a study of source asymmetries and scattering of sound by sound at high intensity; (4) effects of absorption on the interaction of sound beams is a completed study of the role of absorption in second harmonic generation and scattering of sound by sound; and (5) parametric receiving arrays is a completed study of parametric reception in a reverberant environment. GRA

**N91-20866#** Institut Franco-Allemand de Recherches, Saint-Louis (France).
**EFFECT OF NON-RECTANGULAR BLADE TIPS ON BVI NOISE FOR A TWO-BLADED ROTOR**
M. Schaffar, J. Haertig, and P. Gnemmi 5 Jul. 1990 21 p Presented at the 16th European Rotorcraft Forum, Glasgow, Scotland, 18-21 Sep. 1990 Original contains color illustrations
(ISL-CO-217/90; ETN-91-98984) Avail: NTIS HC/MF A03

The vortex lattice method jointly used with local conformal mapping (to transform the thin blade into a thick one) is described. This method is applied to a two bladed rotor with several blade tips (rectangular, forward or backward swept, anhedral, progressive swept, progressive swept and anhedral). The effect of these blade tips on the emmitted Blade Vortex Interaction (BVI) noise is calculated with an acoustic code which is based on the Ffowcs-Williams-Hawkings (FW-H) equation. Two flight conditions are explored. The aerodynamic results (thrust curve, wake evolution, vortex shedding) are analyzed. The noise directivities and the individual pressure signatures show that the PF1 blade tip is interesting for one flight case. Nevertheless, for these two blade tips a decrease (1 to 2 dB) in noise in the rotor plane is obtained (that means especially a reduction of the thickness noise) and a short reduction (1 dB) is also obtained below the rotor plane for the BVI noise in the forward direction. ESA

# 72 ATOMIC AND MOLECULAR PHYSICS

Includes atomic structure, electron properties, and molecular spectra.

**N91-20867#** Maryland Univ., College Park. Dept. of Chemistry and Biochemistry.
**INTRUDER STATES, COEXISTENCE, AND APPROACHES TO DEFORMATION: THE STUDY OF Xe120 AND THE N = 66 ISOTONES**
P. F. Mantica, Jr., B. E. Zimmerman, C. E. Ford, W. B. Walters, D. Rupnik, and E. F. Zganjar (Louisiana State Univ., Baton Rouge.) 1989 15 p Presented at the American Chemical Society (ACS) Symposium on Exotic Nuclear Spectroscopy, Miami Beach, FL, 11-15 Sep. 1989 Prepared in cooperation with Oak Ridge Associated Universities, TN; and Oxford Univ., England

(Contracts DE-FG05-84ER-40159; DE-FG05-88ER-40418; DE-AC05-76OR-00033; DE-AC05-84OR-21400)
(DE91-008144; DOE/ER-40159/163; CONF-8909247-9) Avail: NTIS HC/MF A03

Results of gamma ray and conversion-electron spectroscopic studies of the structure of Te-119, Te-121, Xe-126, and Xe127 are reported. These results are described along with the results of previous studies of intruder structures in the Te and Xe mass region. The observed structures are contrasted with other intruders identified in the Sn, Cd, and Pd isotopes. Results of IBM mixing calculations are shown for the even-even Te nuclides. The role of intruder structures in the development of nuclear deformation is discussed. DOE

**N91-20868#** International Business Machines Corp., San Jose, CA.
**COVALENT AND IONIC CONTRIBUTIONS TO THE BONDING OF ATOMIC AND MOLECULAR ADSORBATES ON METAL SURFACES: A CLUSTER MODEL APPROACH**
Gianfranco Pacchioni, Paul Bagus, M. R. Philpott, and C. J. Nelin 19 Feb. 1990 37 p
(Contract N00014-82-C-0583)
(AD-A229947; TR-24) Avail: NTIS HC/MF A03 CSCL 20/5

The molecular cluster model approach for the description of processes at surface is presented. It involves using finite clusters which contain surface atoms interacting with atomic or molecular adsorbates. Accurate ab initio wavefunctions can be obtained for the clusters and thus makes it possible to describe the bonding in terms that are familiar for molecular systems. The adsorbate-substrate interaction can be analyzed by means of new techniques developed to characterize the bonding as covalent or ionic. This is shown for F on Ag(111) and O and CO on Cu(100) systems. The measures of adsorbate ionicity are (1) the expectation value of a projection operator giving an indication of the number of electrons associated with the adsorbate, (2) the analysis of the dipole moment curve as function of the distance, and (3) the effect of an external electric field on the adsorbate geometry. The consequences of ionic adsorbates on metal surfaces is discussed for two selected topics: adsorption of thiocyanate on Ag electrodes and coadsorption of CO with ionic species. GRA

**N91-20869#** Polytechnic Univ., Farmingdale, NY.
**NONEQUILIBRIUM EFFECTS IN ION AND ELECTRON TRANSPORT Final Report, 1989 - 1990**
Jean W. Gallagher, David E. Hudson, Erich E. Kunhardt, and Richard I. VanBrunt Nov. 1990 476 p
(Grant AF-AFOSR-0453-89; AF Proj. 2301)
(AD-A229961; AFOSR-90-1187TR) Avail: NTIS HC/MF A21 CSCL 20/5

This volume presents the contributions of the participants in the Sixth International Swarm Seminar, held August 2 to 5, 1989, at the Webb Institute in Glenn Cove, New York. The Swarm Seminars are traditionally held as relatively small satellite conferences of the International Conference on the Physics of Electronic and Atomic Collisions (ICPEAC) which occurs every two years. The 1989 ICPEAC took place in New York City prior to the Swarm Seminar. The focus of the Swarm Seminars has been on basic research relevant to understanding the transport of charged particles, mainly electrons and ions, in weakly ionized gases. This field that tends to bridge the gap between studies of fundamental binary atomic and molecular collision processes and studies of electrical breakdown or discharge phenomena in gases. Topics included in the 1989 seminar ranged the gamut from direct determinations of charged-particle collision cross sections to use of cross sections and swarm parameters to model the behavior of electrical gas discharges. The range of subjects covered was in many respects similar to that of previous seminars. GRA

**N91-20870#** Naval Research Lab., Washington, DC.
**COMPLEX ROUTE TO CHAOS IN VELOCITY DRIVEN ATOMS Interim Report, 1 Oct. 1989 - 30 Sep. 1990**
Phouc X. Tran, D. W. Brenner, and C. T. White 5 Nov. 1990 15 p
(AD-A230051; TR-12) Avail: NTIS HC/MF A03 CSCL 20/8

The oscillations of a linear triatomic molecule with the first atom driven at a constant velocity, upsilon, are studied numerically. As upsilon increases, we observe a sequence of transitions from quasiperiodicity to chaos, mode locking, chaos, model locking, chaos, another mode locking and then to chaos before atoms break off. The largest Lyapunov exponent does not rise linearly with the driven velocity. The mode locking structure for the last onset to chaos has a universal fractal dimension 0.871 + 0.001 at a winding number far from the golden mean. GRA

**N91-20871#** Washington Univ., Saint Louis, MO. Dept. of Pharmacology.
**MOLECULAR MECHANISM OF VOLTAGE-DEPENDENT ION CHANNELS Annual Report, 12 Jan. 1989 - 30 Nov. 1990**
Garland R. Marshall 29 Nov. 1990 10 p
(Contract N00014-90-J-1393)
(AD-A229777) Avail: NTIS HC/MF A02 CSCL 20/5

The focus of this research is the interaction of a molecule at the lipid/water interface of a membrane with the external electric field, using peptaibols and the S4 segment of the sodium channel as model systems. Experiments are underway to assess the role of the molecular dipole in sensing the imposed molecular field; the role of alpha helix-310-helix transitions in responding to the imposed molecular field as the transduction mechanism; and the role of the channel mouth in determining the ion selectivity associated with channel opening. Ac-(Lys(alamethicin 1-17)4-NH2, tetramethicin, which was prepared by coupling several small fragments to tetraysine while attached to a solid support, showed an effective concentration dependence 2.7 times that of alamethicin. Other oligomeric pores are in preparation using aza-crown ether scaffolds. GRA

**N91-20872#** Birmingham Univ. (England). School of Physics and Space Research.
**ION AND ELECTRON INTERACTIONS AT THERMAL AND SUPRATHERMAL ENERGIES Final Report, 1 Aug. 1987 - 31 Jul. 1990**
David Smith and Nigel G. Adams 1 Sep. 1990 50 p
(Grant AF-AFOSR-0355-87; AF Proj. 2303)
(AD-A230492; GL-TR-90-0264) Avail: NTIS HC/MF A03 CSCL 20/5

The flowing afterglow/Langmuir probe (FALP) apparatus has been used to study (1) electron attachment reactions of many species including, for the first time, some unstable molecular radicals, and some halogenated benzenes, triflate esters, halomethanes and haloethanes; and (2) dissociative recombination reaction rate coefficients and, for the first time, the neutral products (specifically OH and H radicals) from the dissociative recombination of selected positive ions. The selected ion flow tube has been used to determine the rate coefficients and product ion distributions for many positive ion/neutral reactions, including reactions of ions in the series PHn+(n = 0 to 4), of the rare gas ions Kr+, Kr(2+)Xe(+), and Xe2+ and of the halogen ions F+, Cl+, Br+ and I+. GRA

**N91-20873#** State Univ. of New York, Buffalo. Dept. of Chemistry.
**SPECTRAL AND TEMPORAL DISTRIBUTION OF PHASE-CONJUGATED FLUORESCENT PHOTONS**
Henk F. Arnoldus and Thomas F. George Dec. 1990 25 p
(Contract N00014-90-J-1193)
(AD-A230504; UBUFFALO/DC/90/TR-38) Avail: NTIS HC/MF A03 CSCL 20/5

Spontaneous emission of fluorescence radiation by an atom near the surface of a four-wave mixing phase conjugator is considered. It is shown that the spectral photon distribution consists of two Lorentzians, which have their peaks symmetrically located at the two sides of the pump frequency omega (bar) of the nonlinear crystal. With omega sub 0, the atomic resonance, the line at 2 omega(bar)-omega sub 0 is more than twice as strong as the line at omega sub 0. When the phase-conjugate reflectivity exceeds

unity, the temporal photon distribution exhibits nonclassical behavior. Then, antibunching of photons prevails, and the photon statistics is sub-poissonian. GRA

**N91-20874#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**ENERGY TRANSFER IN SINGLET OXYGEN AND BROMINE MONOFLUORIDE M.S. Thesis**
Barrett F. Lowe Dec. 1990 89 p
(AD-A230614; AFIT/GEP/ENP/90D-2) Avail: NTIS HC/MF A05 CSCL 07/4

The interhalogen molecule, bromine monofluoride (BrF), is currently under study as a potential candidate for a visible chemical laser medium. Previous studies have shown a strong emission from BrF(B3II(O(+))) in the presence of singlet oxygen. While singlet oxygen will pump BrF(X) to BrF(B), the exact mechanism is not known. Chemiluminescence observed from BrF(B) excited by oxygen in a gas flowtube was used to study the energy transfer mechanism. The objective of this research was fourfold. First, the pumping process was identified as a three-body mechanism. Second, the observed vibrational distribution clearly showed the population of the BrF(B) state to be non-Maxwellian. GRA

**N91-20875#** Army Combat Systems Test Activity (Provisional), Aberdeen Proving Ground, MD.
**METHODOLOGY INVESTIGATION OF NEUTRON DEVICE MONITORS Final Report, Oct. 1989 - Sep. 1990**
Craig R. Heimbach Aug. 1990 22 p
(AD-A230636; USACSTA-7005) Avail: NTIS HC/MF A03 CSCL 09/1

Various diodes have been investigated as monitors for 1 MeV equivalent neutrons. One particular diode, the DN-156, has proved suitable. It is not sensitive to thermal neutrons or gamma rays. Production uniformity is sufficiently good that batch calibration is suitable, and individual device calibration is not necessary. The device is not temperature stable, so precautions must be taken to obtain correct results. The DN-156 has been used to calibrate a test reactor neutron field to 9 percent, traceable to a national standard. GRA

**N91-20876#** Naval Surface Warfare Center, Silver Spring, MD.
**PULSE SHAPING A HIGH-CURRENT RELATIVISTIC ELECTRON BEAM IN VACUUM Technical Report, Oct. 1989 - Jul. 1990**
J. D. Miller, R. F. Schneider, H. S. Uhm, K. T. Nguyen, and K. W. Struve 28 Jun. 1990 34 p
(AD-A230674; NAVSWC-TR-90-268) Avail: NTIS HC/MF A03 CSCL 20/7

A simple method for shaping the output current pulse of a relativistic electron beam in vacuum is presented. This method was used to sharpen the risetime of high current relativistic electron beam produced by a 2 MV, 7 kA, 20 ns pulser. The beam nominally has a pulse shape that is triangular in both voltage and current, with a negligible instantaneous energy spread. The desired pulse shape is nominally rectangular in current. The technique utilizes a magnetic lens with a magnitude of approx. 1.5 kG to focus on beam. Passing beam electrons through the magnetic lens causes them to focus at different axial locations downstream from the lens depending upon their energy. The focal point of the beam current peak (corresponding to maximum energy) is then located furthest downstream. An aperture is used near the focus to select a portion of the beam having the desired parameters. GRA

**N91-20877#** Tel-Aviv Univ. (Israel).
**PROBING OF MEMBRANE'S SURFACE BY DYNAMIC MEASUREMENTS OF PROTON DIFFUSION Annual Report, Jan. 1990 - Jan. 1991**
Menachem Gutman 1 Jan. 1991 10 p
(Contract N00014-89-J-1622)
(AD-A230747) Avail: NTIS HC/MF A02 CSCL 20/5

The reaction was followed within a 20 ns time window, and analyzed by numerical integration of the Debye-Smoluchowski operator using a stochastic formalism. By means of this analysis, we determine the diffusion coefficient of the proton, the effective dielectric constant, and the steric hindrance for proton approach due to the anion's adsorption to the membrane. We have demonstrated that proton diffusion studies can be a tool for evaluating physical properties of microscopic and macroscopic aqueous systems. GRA

**N91-20878#** Rome Univ. (Italy). Dipt. di Fisica.
**TOP SEARCH IN ISOLATED SINGLE MUON-JET EVENTS WITH THE UA1 EXPERIMENT**
Aleandro Nisati (Istituto Nazionale di Fisica Nucleare, Rome, Italy) 25 Jan. 1990 13 p Presented at 8th Topical Workshop on Proton Antiproton Collider Physics, Castiglione della Pecaia, Italy, 1-5 Sep. 1989
(Nota-Interna-946; ETN-91-98869) Avail: NTIS HC/MF A03

The steps involved in searching for the top quark at the CERN pp(bar) collider as part of the UA1 experiment are described. The study is based on the analysis of events containing one isolated muon and jets. The contribution of the top quark signature from known processes is discussed. No evidence for the production of a new heavy quark is found. A 95 percent C.L. limit is set for the top mass greater than GeV/C squared based on this analysis alone and for the top mass greater than 61 GeV/C squared including also the dimuon analysis. The semileptonic branching ratio is assumed to be 1/9. A search for the prime quark is discussed. ESA

**N91-20879#** Rome Univ. (Italy). Dipt. di Fisica.
**SEARCH FOR SUPERSYMMETRIC PARTICLES AT LEP: RESULTS AND PROSPECTS**
C. Dionisi (Istituto Nazionale di Fisica Nucleare, Rome, Italy ) 8 Feb. 1990 30 p Presented at 17th International Meeting on Fundamental Physics, Lekeitio, Spain, 23-29 Apr. 1989
(Nota-Interna-947; ETN-91-98870) Avail: NTIS HC/MF A03

Results of research at the LEP (European Large Electron-Positron storage rings) e+e- collider are used to help determine in which direction research in supersymmetric and other areas of particle physics can be the most fruitful. The scenario on SUSY (supersymmetry model), corrected to account for the LEP results, is described. Aspects of the SUSY theory needed for discussion of the LEP results and prospects are summarized. Drawbacks of the standard model in explaining the magnitude of particle masses, charges, current weak mixing angles and other parameters are discussed. ESA

**N91-20880#** Rome Univ. (Italy). Dipt. di Fisica.
**POLARIZABILITY CORRECTIONS IN EXOTIC ATOMS**
M. DeSanctis (Istituto Nazionale di Fisica Nucleare, Rome, Italy ) 23 Apr. 1990 32 p
(Nota-Interna-949; ETN-91-98871) Avail: NTIS HC/MF A03

Polarizability shifts in exotic atoms are analyzed in the same theoretical framework as that used in studying sum rules and photon scattering amplitude. Both the orbiting particle and the nucleus are treated as fermion composite systems. The Coulomb polarizabilities are derived for all the multipole operators. Penetration contributions are briefly studied and relativistic corrections up to an order of 1/sq m are obtained in the dipole limit. ESA

**N91-20881#** Rome Univ. (Italy). Dipt. di Fisica.
**LIMITS ON THE ELECTRON COMPOSITENESS FROM THE BHABHA SCATTERING AT PEP AND PETRA**
Giulio DAgostini (Istituto Nazionale di Fisica Nucleare, Rome, Italy) 28 Jun. 1990 11 p Presented at 25th Rencontre de Moriond on Electroweak Interactions and Unified Theories, Les Arcs, France, 4-11 Mar. 1990
(Nota-Interna-951; ETN-91-98873) Avail: NTIS HC/MF A03

A combined analysis of the published data on Bhabha scattering differential cross sections at (square root of s approximately equal to 30 GeV) is performed. The analysis is used to search for deviations from standard model predictions due to the internal structure of the electron. Particular care is put into finding the most appropriate way of quantifying the results. The combination

of several experiments is found to give sensitivity up to approximately 5 TeV (VV coupling). No deviation from the point-like structure of the electron shows up compatibly with this resolution power. ESA

**N91-20882#** Rome Univ. (Italy). Dipt. di Fisica.
**HOW TO TAG THE HIGH PT JETS INVOLVING THE ANOMALOUS STRUCTURE FUNCTION OF THE PHOTON AT HERA**
Giulio DAgostini and D. Monaldi (Istituto Nazionale di Fisica Nucleare, Rome, Italy ) 28 Jun. 1990 14 p Presented at 25th Int. Conf. on High Energy Physics, Singapore, Aug. 1990
(Nota-Interna-952; ETN-91-98874) Avail: NTIS HC/MF A03

Possibilities offered by HERA detectors in helping identify events where a parton of the proton interacts with a parton of the (quasi) real photon are summarized. The method described, once the parton densities of the proton are determined in the kinematical regions of interest, could give information on the parton density of the photon complementary to those obtainable by F (gamma) sub z measured in gamma-gamma interactions. ESA

**N91-20883#** Rome Univ. (Italy). Dipt. di Fisica.
**ETA/GAMMA TOF DISCRIMINATION IN NaI/Tl AND FOR HEAVY ION EXPERIMENTS**
R. Marovaldi and A. Buccheri (Istituto Nazionale di Fisica Nucleare, Rome, Italy ) 6 Sep. 1990 12 p
(Nota-Interna-956; ETN-91-98877) Avail: NTIS HC/MF A03

The neutron/gamma rejection power of a Time Of Flight (TOF) system in an NaI (TL) cluster is discussed. The TOF resolution reached is considered encouraging and, together with a pulse discrimination system, could allow full rejection of neutron contamination when measuring gamma multiplicities in heavy ion reactions. Ways in which the reaction mechanisms of the process can be elucidated are summarized. Investigation of gamma ray emission is concluded to contribute significantly to a better understanding of equilibration mechanisms. ESA

**N91-20884#** Ames Lab., IA.
**PHOTOION-PHOTOELECTRON COINCIDENCE STUDIES CLUSTERS AND TRANSIENT MOLECULES Ph.D. Thesis**
K. Norwood 16 Nov. 1990 197 p
(Contract W-7405-eng-82)
(DE91-006695; IS-T-1498) Avail: NTIS HC/MF A09

Experimental photoion-photoelectron coincidence (PIPECO) spectra have been obtained at different nozzle stagnation pressures for Ar, Kr, Xe, and CO dimers and trimers in the wavelength regions corresponding to the respective ground states through all states accessible with a photon energy of 20 eV. Ionization energies for all ground states were measured and agree well with previously reported values. The formation of stable dimer ions from fragmentation of larger cluster ions initially produced by photoionization is efficient. For nozzle expansion conditions which minimize the formation of clusters larger than dimers, the intensities of the excited PIPECO bands for all clusters, except Ar2(+) and Ar3(+), are found to be negligible with respect to the ground state PIPECO bands. The PIPECO technique has been used successfully to obtain the mass-selected threshold photoelectron spectra of the SO and S2O transient molecules formed from a microwave discharge, effusive beam source. Analysis of the PIPECO spectra of all the clusters and transient molecules are presented. DOE

**N91-20885#** Washington Univ., Saint Louis, MO. Dept. of Chemistry.
**REACTION STUDIES OF HOT SILICON, GERMANIUM AND CARBON ATOMS**
P. P. Gaspar 1 Nov. 1990 23 p
(Contract DE-AC02-76ER-01713)
(DE91-006921; DOE/ER-01713/170) Avail: NTIS HC/MF A03

The goal of this project was to increase the authors understanding of the interplay between the kinetic and electronic energy of free atoms and their chemical reactivity by answering the following questions: (1) what is the chemistry of high-energy carbon silicon and germanium atoms recoiling from nuclear transformations; (2) how do the reactions of recoiling carbon, silicon and germanium atoms take place - what are the operative reaction mechanisms; (3) how does the reactivity of free carbon, silicon and germanium atoms vary with energy and electronic state, and what are the differences in the chemistry of these three isoelectronic atoms. This research program consisted of a coordinated set of experiments capable of achieving these goals by defining the structures, the kinetic and internal energy, and the charge states of the intermediates formed in the gas-phase reactions of recoiling silicon and germanium atoms with silane, germane, and unsaturated organic molecules, and of recoiling carbon atoms with aromatic molecules. The reactions of high energy silicon, germanium, and carbon atoms created by nuclear recoil were studied with substrates chosen so that their products illuminated the mechanism of the recoil reactions. Information about the energy and electronic state of the recoiling atoms at reaction was obtained from the variation in end product yields and the extent of decomposition and rearrangement of primary products (usually reactive intermediates) as a function of total pressure and the concentration of inert moderator molecules that remove kinetic energy from the recoiling atoms and can induce transitions between electronic spin states. DOE

**N91-20886#** Massachusetts Univ., Amherst. Dept. of Chemistry.
**THEORY OF THE DISSOCIATION DYNAMICS OF SMALL MOLECULES ON METAL SURFACES: FINITE TEMPERATURE STUDIES**
B. E. Jackson Feb. 1991 7 p
(Contract DE-FG02-87ER-13744)
(DE91-008512; DOE/ER-13744/11) Avail: NTIS HC/MF A02

Studies of the dissociative adsorption of diatomics on metals can tell us much about metal catalyzed reactions. Proper theoretical treatments have been hindered by the difficulty of including all important degrees of freedom quantum mechanically. In earlier studies, efficient time dependent methods for surmounting these problems are developed. During this past year models were implemented in which molecular vibration, rotation and translation normal to the surface were treated quantum mechanically. Probabilities for dissociative sticking and rotational excitation were computed as a function of the kinetic and internal energy of the molecule, as well as the surface impact site. Comparisons were made with earlier studies of lower dimensionality. The remaining degrees of freedom are now being included classically in a comparison with experimental studies of H2, N2 and O2. Techniques which were developed for coupling the gas particle to thermal vibrations of the solid were used to study trapping. Sticking probabilities were computed for He, Ne and Ar over a wide range of temperatures, kinetic energies, impact angles and gas-surface potentials. These techniques are now being used to examine the trapping of H2 and other diatomics in the weak precursors often found in dissociative adsorption pathways. DOE

**N91-20887#** Iowa Univ., Iowa City. Dept. of Physics and Astronomy.
**CONFIGURATION SPACE FADDEEV CALCULATIONS**
G. L. Payne, W. H. Klink, and W. N. Ployzou Jan. 1991 27 p
(Contract DE-FG02-86ER-40286)
(DE91-008517; DOE/ER-40286/T3) Avail: NTIS HC/MF A03

The detailed study of few body systems provides one of the most precise tools for studying the dynamics of nuclei. The research program consists of a careful theoretical study of the nuclear few-body systems. During the past year, several aspects of this program were completed. The program was continued using the trinucleon system to investigate the validity of various realistic nucleon-nucleon potentials. Also, the effects of meson-exchange currents in nuclear systems were studied. Initial calculations using the configuration space Faddeev equations for nucleon-deuteron scattering were completed. With modifications to treat relativistic systems, few body methods can be applied to phenomena that are sensitive to the structure of the individual hadrons. A review was completed of Relativistic Hamiltonian Dynamics in Nuclear

and Particle Physics for Advances in Nuclear Physics. Although it is called a review, it is a large document that contains a significant amount of new research. DOE

**N91-20733*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**ATOMIC OXYGEN BEAM SOURCE FOR EROSION SIMULATION**
J. W. Cuthbertson, W. D. Langer, R. W. Motley (Princeton Univ., NJ.), and J. A. Vaughn *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 734-741 (For primary document see N91-20702 12-59)
(NASA Order H-83097-B)
Avail: NTIS HC/MF A14 CSCL 20H

**N91-20735*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**THE EFFECT OF ATOMIC OXYGEN ON POLYSILOXANE-POLYIMIDE FOR SPACECRAFT APPLICATIONS IN LOW EARTH ORBIT**
Sharon K. Rutledge, Jill M. Cooper, and Raymond M. Olle (Cleveland State Univ., OH.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 755-762 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 20H

**N91-20736*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**CHARACTERIZATION OF A 5-eV NEUTRAL ATOMIC OXYGEN BEAM FACILITY**
J. A. Vaughn, R. C. Linton, M. R. Carruth, Jr., A. F. Whitaker, J. W. Cuthbertson, W. D. Langer, and R. W. Motley (Princeton Univ., NJ.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 764-771 (For primary document see N91-20702 12-59)
Avail: NTIS HC/MF A14 CSCL 20H

# 73 NUCLEAR AND HIGH-ENERGY PHYSICS

Includes elementary and nuclear particles; and reactor theory.
For space radiation see *93 Space Radiation.*

**N91-20888#** Naval Research Lab., Washington, DC.
**THE IMPACT OF THE THREE-WAVE INSTABILITY ON THE SPIRAL LINE INDUCTION ACCELERATOR Memorandum Report**
J. Krall and C. M. Tang 23 Nov. 1990 17 p
(AD-A229758; NRL-MR-6752) Avail: NTIS HC/MF A03 CSCL 20/7

The solenoidal and helical quadrupole magnetic fields that are used to transport the high current beam in the spiral line induction accelerator may admit instabilities such as the electromagnetic three wave instability. Previous studies have shown that stability is easily maintained for energies up to approx. 40 MeV. Three wave growth rates for energies exceeding 40 MeV can be less than or equal .001/cm. Strategies are outlined for stabilizing or further reducing growth rates. These are (1) cyclotron detuning, where the instability is detuned by varying the axial magnetic field, (2) damping the instability through the use of discrete quadrupole focusing, which allows the instability to be detuned by varying the quadrupole wavenumber. The effectiveness of de-Qing and cyclotron detuning is discussed for the various instability regimes. GRA

**N91-20889#** Rome Univ. (Italy). Dipt. di Fisica.
**PERFORMANCES OF AN EMULATOR FARM FOR THE DATA PROCESSING OF HIGH ENERGY PHYSICS EXPERIMENTS**
V. Cecconi, G. Ciapetti, R. Giacalone, Aleandro Nisati, M. Torelli, and L. Zanello (Istituto Nazionale di Fisica Nucleare, Rome, Italy ) 20 Sep. 1990 26 p Sponsored by IBM Italia
(ETN-91-98880) Avail: NTIS HC/MF A03

The performance of a dedicated computing facility for the data processing of high energy experiments is presented. The farm is based on the 3081/E processor developed at CERN/SLAC with a 9370 IBM mainframe acting as host for the input/output operations. The use of two different mainframes (9373/20 and 9375/60) is discussed in terms of global performance of the farm and results of the first production run with a five processor farm are presented. The limiting performances of the system as a function of the number of processors are extrapolated from the measured data. ESA

**N91-20890#** Los Alamos National Lab., NM.
**THEORETICAL DESCRIPTIONS OF NEUTRON EMISSION IN FISSION**
D. G. Madland 1990 37 p Presented at the International Atomic Energy Agency (IAEA) Consultants Meeting on Nuclear Emission in the Fission Process, Vienna, Austria, 22-24 Oct . 1990
(Contract W-7405-eng-36)
(DE91-008580; LA-UR-91-437; CONF-9010324-1) Avail: NTIS HC/MF A03

Brief descriptions are given of the observables in neutron emission in fission together with early theoretical representations of two of these observables, namely, the prompt fission neutron spectrum N(E) and the average prompt neutron multiplicity. This is followed by summaries, together with examples, of modern approaches to the calculation of these two quantities. Here, emphasis is placed upon the predictability and accuracy of the new approaches. In particular, the dependencies of N(E) and neutron spectrum upon the fissioning nucleus and its excitation energy are discussed. Then, recent work in multiple chance fission and other recent work involving new measurements are presented and discussed. Following this, some properties of fission fragments are mentioned that must be better known and better understood in order to calculate N(E) and neutron spectrum with higher accuracy than is currently possible. In conclusion, some measurements are recommended for the purpose of benchmarking simultaneous calculations of neutron emission and gamma emission in fission. DOE

**N91-20169#** Joint Publications Research Service, Arlington, VA.
**CONTINUED DEVELOPMENT URGED FOR NUCLEAR POWER SOURCES FOR SPACECRAFT**
German Lomanov *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 94-97 Transl. into ENGLISH from Pravitelstvennyy Vestnik (Moscow, USSR), no. 26, Jun. 1990 p 6-7 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

# 74 OPTICS

Includes light phenomena; and optical devices.
For lasers see *36 Lasers and Masers.* .

**N91-20891** Department of the Navy, Washington, DC.
**PULSED ILLUMINATION PROJECTOR Patent**
William B. Anderson, inventor (to Navy) 5 Jan. 1988 4 p Filed 19 Nov. 1984
(AD-D014716; US-Patent-4,717,862; US-Patent-Appl-SN-672728; US-Patent-Class-315-246) Avail: US Patent and Trademark Office CSCL 20/6

This patent discloses a pulsed illuminator projector for reducing the reverberation levels of reflected light by illuminating a lamp that is pulsed on and off at a specified rate and for a specified time duration. The critical factor is controlling the amount of time the light is on vs. amount of time it is off, and the frequency at which the lamp is pulsed on. The pulsed illuminator projector device reduces the amount of backscatter from particulate matter such

as water, zooplankton, dust, fog, and the like which causes a significant amount of light to reflect back toward the source thereby reducing visibility. Backscatter is reduced through the reduction of direct incident light. As the backscatter is reduced, the distance which objects can be detected is increased. Illumination is controlled directly by pulse length and repetition rate. The device is completely portable and can be hand held as well as mounted on a vehicle and is operable in gaseous or liquid atmosphere.
Author

**N91-20892#** Dayton Univ., OH.
**DIRECT OPTICAL TO MICROWAVE CONVERSION Final Report, Feb. 1989 - Mar. 1990**
Henry F. Taylor Sep. 1990 31 p Prepared in cooperation with Texas A and M Univ., College Station
(Contract F30602-88-D-0028)
(AD-A229856; RADC-TR-90-234) Avail: NTIS HC/MF A03 CSCL 09/5

Support of high frequency fiber optic links through development of innovative higher efficiency techniques to convert optical energy directly to RF Energy. Control of Phases Arrays by optical means in an area of expanding technology development. Fiber optics and other forms of optical waveguide can provide greater accuracy and true time delay in a phase delay network. Methods of improvement in transfer of optical energy to RF Energy are determined. Development of Direct Optical-to-RF-Direct Amplifiers will result in higher efficiency, low noise, optical receivers for fiber optic links with improved performance. This results in longer fiber optic links without repeaters and improved BER or shorter links.
GRA

**N91-20893#** Rome Air Development Center, Griffiss AFB, NY.
**CLUTTER EFFECTS ON OPTICAL CORRELATORS Report, Feb. - Sep. 1989**
Kenneth H. Fielding and Joseph L. Horner Apr. 1990 15 p
(AD-A229921; RADC-TR-90-88) Avail: NTIS HC/MF A03 CSCL 20/6

The effect of varying ground clutter on the performance of optical correlators was examined. The classical matched (CMF), phase-only (POF), and binary phase-only (BPOF) filters were compared. A new definition of the signal-to-clutter ratio (SCR) in the input scene and the signal-to-noise ratio (SNR) in the correlation plane is presented. Simulations show the POF and BPOF always outperform the CMF. The BPOF performs best in scenes with low SCR ratios (high clutter) using the new metric. The POF performs best for all levels of SCR when a block is placed in the filter plane.
GRA

**N91-20894#** United Technologies Research Center, East Hartford, CT.
**DEVELOPMENT OF OPTICAL FIBERS WITH EMBEDDED GRATINGS FOR SENSOR AND SIGNAL PROCESSING APPLICATIONS Final Report, Dec. 1987 - Dec. 1989**
W. W. Morey, W. H. Glenn, and G. Meltz Nov. 1990 38 p
(Contract F19628-88-C-0033)
(AD-A229971; RADC-TR-90-280) Avail: NTIS HC/MF A03 CSCL 20/6

Bragg gratings were fabricated in the core of germanium doped silica optical fibers using a photorefractive property of the glass. The process depends on an oxygen vacancy defect in the germania-silica core manifested by a strong absorption peak occurring in the UV at 245 nm. The absorption can be bleached by irradiation at the adsorbing wavelength leaving behind a residual small refractive index change. By irradiation with a holographic interference pattern, a phase grating of controlled periodicity is introduced into the fiber core. The grating fabrication technique and experiment work defining the optical characteristics of the grating and application to practical devices are described. GRA

**N91-20895#** California Univ., San Diego, La Jolla. Dept. of Electrical and Computer Engineering.
**RESEARCH ON MATERIALS AND COMPONENTS FOR OPTO-ELECTRONICS SIGNAL PROCESSING AND COMPUTING Final Technical Report, 1 Jan. 1989 - 30 Jun. 1990**
William S. Chang, Shigeru Niki, Albert L. Kellner, and H. H. Wieder 30 Jun. 1990 19 p
(Grant AF-AFOSR-0254-89; AF Proj. 2305)
(AD-A230071; AFOSR-90-1171TR) Avail: NTIS HC/MF A03 CSCL 09/5

This project is a continuation of the project (AFOSR 84-0389) under the same title, Research on Materials and Components for Opto-Electronic Signal Processing and Computing, for the period Oct. 1st, 1984 to Nov. 30th, 1988. Recognizing both the importance of spatial light modulators (SLM) to opto-electronic computing and signal processing and the unique material properties of multiple quantum well (MQM) structures, we have focused our investigation on the electro-optical properties and the growth of In(x)Ga(1-x)As/GaAs strained layer material by the molecular beam epitaxy (MBE) method for the SLM's.
GRA

**N91-20896#** State Univ. of New York, Buffalo. Dept. of Chemistry.
**THEORY AND NUMERICAL SIMULATION OF OPTICAL PROPERTIES OF FRACTAL CLUSTERS**
V. A. Markel, L. S. Muratov, Mark I. Stockman, and Thomas F. George Dec. 1990 41 p
(Contract N00014-90-J-1193)
(AD-A230206; UBUFFALO/DC/90/TR/35) Avail: NTIS HC/MF A03 CSCL 12/1

Fractals, as introduced by Benoit Mandelbrot over ten years ago, are scale self-similar mathematical objects possessing nontrivial geometrical properties. There exist various physical realizations of fractals, and here we shall consider what we believe to be one of the most important such realizations, namely, fractal clusters. Attention will be paid mainly to their optical properties. A fractal cluster is a system of interacting material particles called monomers. A theory of linear optical properties of fractal clusters is developed in this report. The theory is based upon the exact properties of dipole polarizability and assumption of the existence of scaling for the dipole excitations (eigenstates) of the fractal. This assumption is self-consistently validated by the results of the theory and is also confirmed by numerical stimulation in the framework of the Monte-Carlo method.
GRA

**N91-20897#** Arizona Univ., Tucson. Optical Sciences Center.
**NOVEL DEVICES FOR ALL-OPTICAL COMPUTING Final Report**
G. I. Stegeman 1990 6 p
(Contract N00014-86-K-0719)
(AD-A230323) Avail: NTIS HC/MF A02 CSCL 20/6

Two nonlinear optics devices for serial processing of optical information were investigated. The first-generation devices were all-optical switches in guided wave formats, nonlinear directional couplers, and optically tunable gratings. Waveguides were fabricated in semiconductor-doped glass. For the first time, picosecond switching was demonstrated in a nonlinear directional coupler, a device that is useful for implementing optical logic switching. Multiple gratings also were fabricated in nonlinear thin film InSb antimonide waveguides and their nonlinear responses were studied. Input grating couplers exhibited a bistable response suitable for optical logic. The reflection and transmission coefficients of a nonlinear distributed feedback grating depend on the incident guided wave beam power. For a weak beam near the Bragg condition, the grating reflectivity was tuned by a strong beam far off the Bragg condition. Finally, the combination of a nonlinear grating input coupler and a nonlinear distributed feedback grating led to bistability at greatly reduced input power levels.
GRA

**N91-20898#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**ANGLE OF ARRIVAL DETECTION THROUGH ARTIFICIAL NEURAL NETWORK ANALYSIS OF OPTICAL FIBER INTENSITY PATTERNS M.S. Thesis**
Scott Thomas Dec. 1990 107 p
(AD-A230386; AFIT/GE/ENG/90D-62) Avail: NTIS HC/MF A06 CSCL 20/6

The optical sensors of United States Air Force reconnaissance vehicles, such as satellites, are subject to temporary or permanent blinding from hostile (or threat) laser radiation. By detecting and determining the angle of arrival (AOA) of the hostile radiation, the reconnaissance vehicle may be able to protect its optical sensors by taking evasive maneuvers or by shutting down the optical sensor (such as closing a shutter) until the threat has passed. In addition, the vehicle can relay information to its ground terminal allowing the intelligence community to determine the source of the hostile laser radiation. This thesis demonstrated that an intensity pattern out of a short piece of optical fiber could be used to determine the angle of arrival (AOA), to within 0.1 deg, of the incident laser energy on the front of the optical fiber. The optical fiber was a one-inch-long, 3mm-diameter, multimode, step-index, plastic fiber. The optical fiber was mounted to the front end of a charge injection device (CID) camera. The CID camera's angle with respect to the incident laser energy, a uniform amplitude plan wave, would be varied by a computer controlled rotational stage. The output of the CID camera was captured by Spiricon software. Captured outputs representing various AOAs were processed to provide template or test feature vectors. The processing method used a fast Fourier transform routine to create a 24 component low frequency feature vector. Two classification methodologies were used: a Eucledian distance method and a radial basis function neural network. GRA

**N91-20899#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**DETERMINATION OF THE OPTICAL PROPERTIES OF ORGANIC THIN FILMS BY SPECTROSCOPIC ELLIPSOMETRY M.S. Thesis**
Mark L. Sward Dec. 1990 95 p
(AD-A230427; AFIT/GEP/ENP/90D-8) Avail: NTIS HC/MF A05 CSCL 07/6

This theses demonstrated the feasibility of determining the optical properties of organic and polymer thin films through the use of Spectroscopic Ellipsometry (SE). Tan Psi and cos Delta data from 300 to 800 nanometers (NM) were taken with a Rudolph Research s2000 spectroscopic ellipsometer four samples: indium tin oxide (ITO) coated glass; five layer poly-benzyl-L glutamate (PBLG) organic film on ITO coated glass; eight layer PBLG film on ITO coated glass; and a thiophene polymer film on a microscope slide. The data sets were fit to a choice of four computer models based on a paper written by Dwight Berreman in 1972. The four were written in MATLAB to take advantage of its matrix manipulative capabilities. The models were: a single layer isotropic film on an isotropic substrate; a single layer anisotropic film on an isotropic substrate; two isotropic films on an isotropic substrate; and two anisotropic films on an isotropic substrate. Using only tan Psi data over a restricted wavelength region, all four data sets were fit to variances of 0.01 or less. GRA

**N91-20900#** Carnegie-Mellon Univ., Pittsburgh, PA. Optical Data Processing.
**OPTICAL NEURAL NETS FOR SCENE ANALYSIS Semiannual Report, Apr. - Sep. 1990**
David Casasent 23 Nov. 1990 8 p
(Contract DAAH01-89-C-0418; ARPA Order 6671)
(AD-A229794; DARPA/SEMI/1090) Avail: NTIS HC/MF A02 CSCL 20/6

The approach is hybrid and multidisciplinary. Pattern recognition and neural net techniques were married. Also married were optical and digital technologies. A hybrid neural net thus results. The use was studied of one basic hybrid architecture that is useful for implementing various optimization and adaptive neural nets. The work thus distinguishes between these two general classes of neural nets (optimization and adaptive) with both being realizable on the same basic hybrid architecture. GRA

**N91-20901#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**CHARACTERIZATION OF BARIUM TITANATE AS AN OPTICAL AMPLIFIER M.S. Thesis**
George A. Vogel Dec. 1990 95 p
(AD-A230532; AFIT/DS/ENG/90D-3) Avail: NTIS HC/MF A05 CSCL 09/5

The introduction of two-beam coupling in photorefractive materials has resulted in an extensive amount of research into their use as optical processing/computing elements. The theoretical equations are developed for two-beam coupling in barium titanate as an optical amplifier. One of the factors which limits the optical gain in photorefractive crystals is the loss of pump beam power to the amplification of parasitic light (beam fanning). This parasitic light is produced by light scattered from the pump beam by imperfections on both the crystal face and within the crystal. Through the analysis of signal and noise amplification as functions of pump and signal beam angles relative to the crystal c-axis, an optimum pump angle is defined which maximizes signal gain and minimizes the energy lost to beam fanning. The determination of an optimum gain is based upon a desired dynamic range and the crystal scattering characteristics. A potential application for the barium titanate optical amplifier is investigated in a system which produces negative feedback using destructive interference. Applications for such a system include image restoration, linear amplification, and image filtering. GRA

**N91-20902#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**DESIGN OF A LINEAR GAUSSIAN CONTROL LAW FOR AN ADAPTIVE OPTICS SYSTEM M.S. Thesis**
Mark A. VonBokern Dec. 1990 18 p
(AD-A230547; AFIT/GE/ENG/90D-65) Avail: NTIS HC/MF A03 CSCL 20/5

This thesis considers the design of a linear quadratic Gaussian (LQG) controller for a ground-based adaptive-optics telescopes. The incoming aberrated image is reflected from a 97-element piezoelectric mirror, then measured with a Hartmann-type wavefront sensor. A Kalman filter processes the outputs of the wavefront sensor and obtains estimates of system states. A linear quadratic regulator processes these state estimates and determines an appropriate set of commands for the deformable mirror. Atmospheric distortion is modeled as a set of fourteen Zernike coefficients whose dynamic behavior is produced by excitation of a set of shaping filters by zero-mean Gaussian white noise. The response of the mirror to control voltages is modeled as a set of Zernike coefficients whose dynamics are modeled as deterministic first-order systems. The entire control system is simulated using the multimode simulation for optimal filter evaluation (MSOFE) software. GRA

**N91-20903#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**NONLINEAR INTERFEROMETRY: OPTICAL IMAGE ADDITION/SUBTRACTION AND NOVELTY FILTERS M.S. Thesis**
Gordon T. Hengst Dec. 1990 62 p
(AD-A230556; AFIT/GEO/ENP/90D-2) Avail: NTIS HC/MF A04 CSCL 09/5

This thesis investigated the performance characteristics of a beam fanning novelty filter and designed a switchable optical image adder/subtractor. The filter spatial resolution, contrast ratio, onset time, and velocity response were measured for both z-cut and 45 deg cut BaTiO3 crystals in the beam fanning configuration. Experimental results show that the special 45 deg cut crystal produces the best overall beam fanning novelty filter. In addition, switchable optical image subtraction and addition were demonstrated for the first time using a modified Michelson interferometer configured with a phase-conjugating mirror and an

adjustable length leg. The system demonstrated addition and subtraction with one-dimensional and two-dimensional images. The adder/subtractor can be switched from coherent subtraction to incoherent addition by biasing a set of e-o crystals which switches the beam in one of the legs of the interferometer into an extra length. The extra length is greater than the coherence length of the laser so that incoherent addition results. The thesis concludes with a brief discussion of industrial and military system applications of the novelty filter and adder/subtractor. GRA

**N91-20904#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**OPTICAL IMAGE SEGMENTATION USING WAVELET FILTERING TECHNIQUES M.S. Thesis**
Christopher P. Veronin Dec. 1990 97 p
(AD-A230584; AFIT/GEO/ENG/90D-09) Avail: NTIS HC/MF A05 CSCL 25/2

This research effort successfully implemented an automatic, optically based image segmentation scheme for locating potential targets in a cluttered FLIR image. Such a design is critical to achieve real-time segmentation and classification for machine vision applications. The segmentation scheme used in this research was based on texture discrimination and employs orientation specific, bandpass spatial filters as its main component. The orientation specific, bandpass spatial filters designed during this research include symmetrically located circular apertures implemented on heavy, black aluminum foil; cosine and sine Gabor filters implemented with detour-phase computer generated holography photoreduced onto glass slides; and symmetrically located circular apertures implemented on a liquid crystal television (LCTV) for real-time filter selection. The most successful design was the circular aperture pairs implemented on the aluminum foil. Segmentation was illustrated for simple and complex texture slides, glass template slides, and static and real-time FLIR imagery displayed on an LCTV. GRA

**N91-20905#** Naval Postgraduate School, Monterey, CA.
**A GENERALIZATION OF SNELL'S LAW M.S. Thesis**
Michael L. Hawkins 1 Jun. 1990 82 p
(AD-A230653) Avail: NTIS HC/MF A05 CSCL 20/5

This thesis presents several derivations of Snell's Law of Refraction and one of the principle of reflection. In all of these, we place different constraints upon the problem and produce the familiar laws governing reflection and refraction. The main result of this research is the expression found for Snell's Law of Refraction in which the velocity of the light particles in the medium depends upon direction. We also use inverse problems to find the index of refraction needed to move along any desired family of curves. Finally, we derive a general expression that generates a family of curves given any index of refraction. This research has several applications in the area of acoustical and optical wave propagation. In the area of acoustics, the inverse problems enable us to predict the path followed by sound waves for a given medium. This has a military use in the area of prosecuting submarine contacts and in ocean bottom surveys. The inverse problems also have applications to the bending of light rays used in laser technology. Although this paper derives several generalizations of Snell's Law of Refraction there are still areas that require further research. GRA

**N91-20906#** Institut National des Sciences Appliquees, Lyon (France). Lab. de Mecanique des Fluides et Thermique.
**MEASUREMENT OF DIRECTIONAL HEMISPHERIC REFLECTIVITY OF OPAQUE METALLIC AND NON-METALLIC MATERIALS. DEVELOPMENT OF A REFLECTOMETER USING PARABOLIC MIRRORS Ph.D. Thesis [MESURE DE LA REFLECTIVITE SPECTRALE DIRECTIONNELLE-HEMISPHERIQUE DE MATERIAUX OPAQUES METALLIQUES ET NON METALLIQUES. MISE AU POINT D'UN REFLECTOMETRE A MIROIRS PARABOLIQUES]**
Mirza AlHamwi (Damascus Univ., Syria ) 1990 145 p In FRENCH; ENGLISH summary
(INSA-IDI-19001; ETN-91-98893) Avail: NTIS HC/MF A07

The growing need for thermophysical data, particularly spectral radiative properties of material, requires the choice of an appropriate means of measurement. The concept and operating principles for a reflectometer with two parabolic mirrors is developed and presented. A reminder of the definitions of radiation properties of opaque materials is presented. The relationship linking these parameters, as well as the definitions of various fundamental notions of the radiation are given. A synthesis of the different techniques for measuring the radiative properties of materials is presented with the purpose of showing their evolution up to now. A detailed description of the different components of the proposed reflectometer is given. The alignment of the experimental set up components is explained. The operating principles of the system, together with its measurements or transfer equation, and the estimation of the accuracy of the method of measurement, are given. The measurements of the directional/hemispherical monochromatic reflectivity of 18 samples are reported. These measurements are obtained for wavelengths situated in the near and middle infrared range and for angles of incidence varying between 35 and 75 degrees. ESA

**N91-20102*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**FIBER-OPTIC-BASED CONTROLS**
Gary T. Seng *In its* Aeropropulsion 1991 Mar. 1991 11 p (For primary document see N91-20086 12-07)
Avail: NTIS HC/MF A24 CSCL 20F

**N91-20663*#** Lockheed Engineering and Sciences Co., Houston, TX.
**INVESTIGATION OF VARYING GRAY SCALE LEVELS FOR REMOTE MANIPULATION**
John M. Bierschwale, Mark A. Stuart, and Carlos E. Sampaio *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 172-178 (For primary document see N91-20641 12-59)
(Contract NAS9-17900)
Avail: NTIS HC/MF A21 CSCL 20F

# 75 PLASMA PHYSICS

Includes magnetohydrodynamics and plasma fusion.

For ionospheric plasmas see *46 Geophysics*. For space plasmas see *90 Astrophysics*.

**N91-20907#** GT-Devices, Alexandria, VA.
**HEATING OF A LIQUID/VAPOR MIXTURE BY A PULSED ELECTRIC DISCHARGE Final Report, 1 Jul. 1987 - 30 Jun. 1990**
R. L. Burton, B. K. Hilko, and F. D. Witherspoon 31 Aug. 1990 75 p
(Contract F49620-87-C-0061)
(AD-A230272; GTD-90-7) Avail: NTIS HC/MF A04 CSCL 20/9

A liquid fueled, pulsed electric discharge was studied to identify the energy exchange and mixing processes occurring between the liquid, vapor, and plasma components. Liquid water, injected into a small bore (3.5 to 5.0 mm diameter) capillary tube, was subjected to power pulses of up to 5 MW for a 15 to 60 microseconds. Experiments were performed with a variety of discharge and liquid injection conditions. A complex, highly transient sequence of heating and vaporization events occurs as revealed in detailed studies of the plasma optical emissions and resistivity. A 1-D, one fluid model was developed, and numerical simulations were performed to help isolate the basic physical processes dominating the discharge dynamics. GRA

**N91-20908#** Air Force Weapons Lab., Kirtland AFB, NM.
**BIBLIOGRAPHY OF DOCUMENTS RELATED TO THE THEORY, OPERATION, PERFORMANCE AND APPLICATIONS OF COAXIAL PLASMA GUNS, REVISION Final Report**

David W. Price Nov. 1990 244 p
(AD-A229799; WL-TR-90-77) Avail: NTIS HC/MF A11 CSCL 20/9

Coaxial plasma guns are used to create physical conditions (plasma and dense plasma foci) of interest to the Air Force. Experimental and theoretical coaxial plasma gun research has been performed since the early 1960's to the present. Research on coaxial plasma gun topics has been done in the Soviet Union, East and West Europe, Japan, the United States, and the Third World. This is the second bibliographic collection of unclassified unlimited distribution references dealing with coaxial plasma guns. The references deal with the theory, operational behavior, performance and applications of coaxial plasma guns and dense plasma focuses (foci) under laboratory research conditions. Other related topics are referenced as well. A total of 1050 separate documents and reports are listed. GRA

**N91-20909#** California Univ., Los Angeles. Dept. of Physics.
**CONVERSION OF ELECTROSTATIC AND ELECTROMAGNETIC WAVES IN A PLASMA AT THE PEAK OF A PARABOLIC DENSITY PROFILE**
D. E. Hinkel-Lipsker, B. D. Fried, and G. J. Morales Dec. 1990 18 p Sponsored by ONR and DOE
(AD-A230560; PPG-1338) Avail: NTIS HC/MF A03 CSCL 20/9

Analytic expressions for the reflection, transmission, and mode conversion coefficients for electromagnetic and Langmuir waves in an unmagnetized plasma with a parabolic density profile are found for both the direct problem (incident electromagnetic wave) and the inverse problem (incident Langmuir wave). In contrast to the linear profile problem, the absorption depends explicitly on the value of collision frequency (cold model) or temperature (warm plasma), but a transformation of parameters relates the results for these two limits. GRA

**N91-20910#** California Univ., San Diego, La Jolla. Inst. for Pure and Applied Physical Sciences.
**PURE ELECTRON PLASMAS NEAR THERMAL EQUILIBRIUM Final Technical Report, 1 Jun. 1982 - 30 Sep. 1990**
J. H. Malmberg, C. F. Driscoll, and T. M. ONeil Nov. 1990 40 p
(Contract N00014-82-K-0621)
(AD-A230627) Avail: NTIS HC/MF A03 CSCL 20/9

Plasmas are the central element in many physical systems, including devices to generate radiation or high tensity beams of particles. Plasma effects are important in modern high current accelerator concepts, especially collective effect accelerators. They are central to the thermonuclear reactor problem, and of course outdoor plasmas dominate the physics of a large portion of the known universe. The physics of these systems can be very complex, and most of the devious ways by which plasmas manage to cross magnetic fields are not yet well understood. The research seeks to obtain tests of plasma theory under the simplest possible circumstances, and when the theory is inadequate, to develop it further. The ultimate motivation was to improve the understanding for application to a variety of physical systems. The direction for the program has been determined by the apparatus and by the internal logic of the science. Some research results topics are as follow: The Electron Containment Apparatus, Transport to Equilibrium; Experiments, Transport to Equilibrium Theory, Anisotropic Temperature Relaxation, Strongly Correlated State and Normal Modes, Fluid Instabilities and Turbulence, Vortex Dynamics, Negative Temperature Equilibria, Ion-Electron Scaling, Plasmas Near the Brillouin Limit, Induced Wave Damping and Transport, Nonlinear and Finite Length Diocotron Modes. GRA

**N91-20911#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**ELECTRON KINETIC STUDIES UTILIZING THE SOLUTION OF THE TIME-DEPENDENT COLLISIONAL BOLTZMANN EQUATION M.S. Thesis**
William M. Hilbun Sep. 1990 123 p
(AD-A230753; AFIT/GEP/ENP/90D-1) Avail: NTIS HC/MF A06 CSCL 20/9

In a continuing effort to analyze plasmas generated in a variety of ways, several refinements and improvements were added to a numerical solution of the time dependent collisional Boltzmann equation. The computational method utilized is based on the Rockwood formalism, and includes elastic collisions, excitation, ionization, and superelastic collisions from multiple states. Attachment is also included. A nonuniform energy grid is incorporated into the method of solution, requiring new finite differenced representations for the electron flux terms from field, recoil, and electron electron interactions. All of these terms are tested independently and validated against analytic results. Implementation, complete with inelastic collisions, is validated against experimental transport data for both molecular and rare gases. A method for dynamically allocating the energy grid is an effort to optimize the computation is developed and evaluated. The inclusion of the nonuniform grid results in the consideration of larger energy ranges than previously possible. GRA

**N91-20912#** Maryland Univ., College Park.
**MICROWAVE GENERATION FOR MAGNETIC FUSION ENERGY APPLICATIONS**
T. M. Antonsen, Jr., W. W. Destler, V. L. Granatstein, B. Levush, and I. D. Mayergoyz Jan. 1991 45 p
(Contract DE-FG05-87ER-52147)
(DE91-008280; DOE/ER-52147/4) Avail: NTIS HC/MF A03

This progress report encompasses work on three separate projects, all related to developing sources for electron cyclotron resonance heating of magnetic fusion plasmas. The report is therefore divided into three parts as follows: free electron lasers with small period wigglers; theory and modeling of high frequency, high power gyrotron operation; and depressed collectors for energy recovery in gyrotrons. Task A is experimental and eventually aims at developing CW sources for ECRH at frequencies as high as 600 GHz. Task B provides gyrotron theory and modeling in support of the gyrotron development programs at MIT and Varian. Task C was phased out in the current contract year but recent publications are included in this report in order to create a permanent record for the use of future researchers with interest in the topic of increasing gyrotron efficiency through the use of depressed collectors. DOE

**N91-20913#** General Atomic Co., San Diego, CA.
**LATEST RESULTS FROM DIII-D AND THEIR IMPLICATIONS FOR FUTURE DEVICES**
A. P. Colleraine and J. L. Luxon Feb. 1991 13 p Presented at the 9th Topical Meeting on Technology of Fusion Energy, Oak Brook, IL, 7-11 Oct. 1990
(Contract DE-AC03-89ER-51114)
(DE91-008499; GA-A-20299; CONF-901007-61) Avail: NTIS HC/MF A03

The DIII-D Tokamak has become one of the major sources of physics and technology data for the design of future large machines such as ITER and CIT. In large part this is because of its extremely flexible design and the ability to run tests or add new diagnostic devices with a minimum of down-time and expense. Fundamental plasma physics studies are still the major focus of the experimental program, but increasingly, new ways are looked for to answer the complex fusion technology questions emerging from the design studies for the next generation devices. Recent results have demonstrated world record beta plasmas, long quiescent H-mode operation, partial noninductive current drive using both neutral beam and RF power injection, single- and double-null divertor operation, and divertor particle- and heat load management. The recently installed Advanced Divertor hardware will allow critical transport experiments to be run with independent control of the density. It will also permit the concept of dc helicity injection current drive to be tested. The most important recent findings are summarized and a few of the many interesting problems that are now under study to address fusion technology questions are outlined. DOE

**N91-20914#** Lawrence Livermore National Lab., CA.
**MODELING OF WEAKLY NONLINEAR HYDRODYNAMIC INSTABILITIES IN INERTIAL FUSION**
S. W. Haan 25 Jan. 1991 19 p Presented at the International Conference on Research Trends in Inertial Confinement Fusion, La Jolla, CA, 4-6 Feb. 1991
(Contract W-7405-eng-48)
(DE91-008729; UCRL-JC-105733; CONF-910247-1) Avail: NTIS HC/MF A03

Hydrodynamic instabilities are being studied at Livermore with a combination of theoretical, computational, and experimental approaches. Recent emphasis has been on understanding the weakly nonlinear phase. We discuss a second-order theory for this phase, and describe briefly relevant experimental and computational work. We argue that for the fully nonlinear phase on ablatively stabilized foils, a simple saturation model is probably appropriate, even though such a model is not appropriate for fully nonlinear classical Rayleigh-Taylor instability growth. DOE

**N91-20915#** Lawrence Livermore National Lab., CA.
**THEORY AND SIMULATION OF RAMAN SCATTERING IN INTENSE, SHORT PULSE LASER PLASMA INTERACTIONS**
S. C. Wilks, W. L. Kruer, A. B. Langdon, P. Amendt, D. C. Eder, and C. J. Keane 1 Feb. 1991 8 p Presented at the OE/LASE '91: 4th Society of Photo-Optical Instrumentation Engineers (SPIE) International Symposium, Los Angeles, CA, 20-25 Jan. 1991
(Contract W-7405-eng-48)
(DE91-008734; UCRL-JC-106277; CONF-910123-15) Avail: NTIS HC/MF A02

We report on the stimulated Raman scattering (SRS) that occurs when short (approximately 50 to 100 femtoseconds), intense (I approximately 2 times 10(sup 17) W/cm sup 2) laser pulses are focused into a plasma, or a neutral gas which quickly becomes a plasma due to multiphoton ionization. Review of the usual SRS growth rates will be given, followed by a discussion on how this theory is modified for short pulses. It is found that for some recombination x ray laser schemes employing short pulses, the Raman instability can potentially heat the electrons to levels that would greatly reduce the efficiency of such a device. However, there are areas in parameter space where the temperature of heated electrons can be kept to acceptable levels. One dimensional, relativistic, particle-in-cell (PIC) simulations are presented. DOE

**N91-20916#** Lawrence Livermore National Lab., CA.
**HYLIFE-II INERTIAL CONFINEMENT FUSION REACTOR DESIGN**
R. W. Moir 14 Dec. 1990 9 p Presented at the 9th Topical Meeting on Technology of Fusion Energy, Oak Brook, IL, 7-11 Oct. 1990
(Contract W-7405-eng-48)
(DE91-008736; UCRL-JC-103816-Rev-1; CONF-901007-6) Avail: NTIS HC/MF A02

The HYLIFE-2 inertial fusion power plant design study uses a liquid fall, in the form of jets to protect the first structural wall from neutron damage, x rays, and blast to provide a 30-y lifetime. HYLIFE-1 used liquid lithium. HYLIFE 2 avoids the fire hazard of lithium by using a molten salt composed of fluorine, lithium, and beryllium (Li2, BeF4) called Flibe. Access for heavy-ion beams is provided. Calculations for assumed heavy-ion beam performance show a nominal gain of 70 at 5 MJ producing 350 MJ, about 5.2 times less yield than the 1.8 GJ from a driver energy of 4.5 MJ with gain of 400 for HYLIFE-1. The nominal 1 GWe of power can be maintained by increasing the repetition rate by a factor of about 5.2, from 1.5 to 8 Hz. A higher repetition rate requires faster re-establishment of the jets after a shot, which can be accomplished in part by decreasing the jet fall height and increasing the jet flow velocity. Multiple chambers may be required. In addition, although not considered for HYLIFE-1, there is undoubtedly liquid splash that must be forcibly cleared because gravity is too slow, especially at high repetition rates. Splash removal can be accomplished by either pulsed or oscillating jet flows. The cost of electricity is estimated to be 0.09 $/kW times h in constant 1988 dollars, about twice that of future coal and light water reactor nuclear power. The driver beam cost is about one-half the total cost. DOE

**N91-20917#** Lawrence Livermore National Lab., CA.
**SUPRATHERMAL PARTICLE GENERATION AND OTHER PLASMA EFFECTS IN LASER FUSION**
W. L. Kruer 19 Dec. 1990 16 p Presented at the International Dawson Symposium on the Physics of Plasma, Los Angeles, CA, 24-25 Sep. 1990
(Contract W-7405-eng-48)
(DE91-008742; UCRL-JC-105830; CONF-9009337-1) Avail: NTIS HC/MF A03

Two basic plasma topics important to the understanding of laser plasma coupling are suprathermal electron generation and nonlinear ion waves. Some old and new results are discussed, including hot electron generation in hohlraum targets. DOE

**N91-20918#** General Atomic Co., San Diego, CA.
**PROFILE OPTIMIZATION AND HIGH BETA DISCHARGES AND STABILITY OF HIGH ELONGATION PLASMAS IN THE DIII-D TOKAMAK**
T. S. Taylor, M. S. Chu, J. R. Ferron, F. J. Helton, W. Howl, G. L. Jackson, T. H. Jensen, A. G. Kellman, L. L. Lao, and R. J. LaHaye et al Feb. 1991 19 p Presented at the 13th International Conference on Plasma Physics and Controlled Nuclear Fusion Research, Washington, DC, 1-6 Oct. 1990
(Contract DE-AC03-89ER-51114)
(DE91-008921; GA-A-20283; CONF-901025-46; IAEA-CN-53/A-3-1) Avail: NTIS HC/MF A03

The maximum experimental volume average toroidal beta in DIII-D scales with the plasma current divided by the plasma minor radius and the toroidal field, beta(sub T) proportional to I/alpha B. Beta(sub T) = 11 percent has been achieved at high normalized current by operating at high plasma elongation, kappa = 2.3, and high triangularity, delta = 0.8, near the axisymmetric stability limit. In a limited range of I/alpha B, beta(sub T)(percent) = 5I/alpha B (MA/m/T) has been obtained. Stability calculations indicate that the high beta stability limit depends on the profiles of the current density, and the pressure. DOE

**N91-20919#** General Atomic Co., San Diego, CA.
**ELECTRON CYCLOTRON HEATING AND CURRENT DRIVE RESULTS FROM THE DIII-D TOKAMAK**
T. C. Luce, R. Harvey, J. Lohr, R. Prater, R. Snider, B. Stallard, R. Stockdale, R. A. James, J. deHaas (Lawrence Livermore National Lab., CA.), and A. Fyaretdinov et al Nov. 1990 14 p Presented at the 13th International Conference on Plasma Physics and Controlled Nuclear Fusion Research, Washington, DC, 1-6 Oct. 1990
(Contract DE-AC03-89ER-51114)
(DE91-008922; GA-A-20281; CONF-901025-44; IAEA-CN-53/E-1-2) Avail: NTIS HC/MF A03

Auxiliary heating experiments with electron cyclotron heating have been carried out in the DIII-D tokamak. Waves at 60 GHz have been launched at power levels up to 1.4 MW from both the high-field and low-field side with the appropriate polarization for damping at the fundamental resonance (2.14 T). Confinement was studied in L-mode and H-mode plasmas for a single-null, open divertor geometry. For L-mode discharges, the energy confinement scaling agrees well with the ITER-89 power law or offset linear scaling relations. With strong off-axis heating, the electron temperature profile remains peaked, and power balance analysis indicates that the transport cannot be described by a purely diffusive model. In H-mode confinement plasmas, the magnitude and scaling of the confinement time are equal to that of plasmas heated by neutral beam injection (NBI), if the energy stored in the fast ions is removed in the NBI cases. A major issue for steady-state H-mode plasmas is control of the edge-localized mode (ELM) behavior. By moving the resonance location +/- 5 cm around the separatrix, the frequency of giant ELMs can be changed by a factor of three. Non-inductive current drive with electron cyclotron waves has also been investigated. Driven currents up to 70 kA have been observed,

but the current drive is enhanced by the residual dc electric field. Currents aiding and opposing the Ohmic current have been measured. The magnitude of the current for co-current drive is greater than expected from modeling which includes trapped particle effects, but no electric field. Preliminary calculations including the residual dc electric field can account for the observed enhancement. DOE

**N91-20920#** General Atomic Co., San Diego, CA.
**DIVERTOR-PLASMA STUDIES ON DIII-D**
D. N Hill, A. Futch, G. Porter, M. E. Rensink, T. Rognlien (Lawrence Livermore National Lab., CA.), T. W. Petrie, G. L. Jackson, R. J. LaHaye, B. Leikind, and S. Lippmann et al Nov. 1990 18 p Presented at the 13th International Conference on Plasma Physics and Controlled Nuclear Fusion Research, Washington, DC, 1-6 Oct. 1990
(Contracts DE-AC03-89ER-51114; W-7405-eng-48; DE-AC04-76DP-00789; DE-AC05-84OR-21400; DE-FG03-89ER-51121)
(DE91-008923; GA-A-20280; CONF-901025-43; IAEA-CN-53/G-1-3) Avail: NTIS HC/MF A03

This paper presents an overview of recent results from divertor physics studies in DIII-D. Heat flux measurements at input power levels up to 20 MW show that steady divertor heat loads of up to 4 MW/sq m are obtained in H-mode discharges with ELMs. No carbon blooms are observed. The heat flux profile is highly peaked at the outside strike point in single-null discharges, and is up/down asymmetric in double-null discharges. Recent experiments with gas injection below the X-point have demonstrated a factor of two reduction in the peak divertor heat flux for H-mode plasmas at these power levels. These heat flux data, along with measurements of the n(sub e) and T(sub e) profiles at the divertor are being used to help interpret the first reported measurements of the erosion profile for a set of graphite divertor tiles exposed to several months of high power tokamak operation. We have now modified the divertor hardware in order to carry out experiments with divertor biasing, baffling, and pumping. DOE

**N91-20921#** California Univ., Berkeley. Electronics Research Lab.
**SIMULTANEOUS POTENTIAL AND CIRCUIT SOLUTION FOR BOUNDED PLASMA PARTICLE SIMULATION CODES**
J. P. Verboncoeur, M. V. Alves, and V. Vahedi Aug. 1990 21 p
(Contract DE-FG03-86ER-53220)
(DE91-008959; UCB/ERL-M-90/67) Avail: NTIS HC/MF A03

A second-order accurate method for solving the combined potential and circuit equations in an electrostatic bounded plasma PIC simulation is presented. The boundary conditions include surface charge on the electrodes, which are connected to a series RLC circuit with driving terms V(t) and I(t). The solution is obtained for planar, cylindrical, and spherical electrodes. The result is a tridiagonal matrix which is readily solved using well-known methods. The method is implemented in the codes PDP1 (Plasma Device Planar 1D), PDC1 (Cylindrical), and PDS1 (Spherical). DOE

**N91-20922#** National Inst. for Fusion Science, Nagoya (Japan).
**ELECTROSTATIC DRIFT MODE IN TOROIDAL PLASMA WITH MINORITY ENERGETIC PARTICLES**
T. Yamagishi Feb. 1991 22 p
(NIFS-74; ISSN-0915-633X) Avail: NTIS HC/MF A03

The electrostatic drift wave theory is developed in the toroidal plasma with minority energetic particles and temperature inhomogeneities by taking into account the global toroidal gyromotion and arbitrary Larmor radius effect of the particles, making use of the toroidal propagator. When the toroidal eigenmode equation is approximated by the Weber type function, the dispersion relation indicates that the toroidal effect strongly destabilizes the ion drift mode even in uniform temperature plasmas. The electrostatic toroidal drift ion mode is insensitive to the presence of energetic ions with the Maxwellian distribution except for small Larmor radius and small toroidal effects cases (cylindrical fluid like plasmas), in which the mode is stabilized by the energetic ions. Author

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Includes superconductivity.

For related information, see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers.*

**N91-20923#** California Univ., Berkeley. Lawrence Berkeley Lab. Materials and Chemical Sciences Div.
**FRESNEL FRINGE EFFECTS AT INTERFACES OF THIN MULTILAYER STRUCTURES**
Tai D. Nguyen, Ronald Gronsky, and Jeffrey B. Kortright Mar. 1990 6 p Presented at the 12th International Congress for Electron Microscopy, Seattle, WA, 12-18 Aug. 1990
(Contracts DE-AC03-76SF-00098; F49620-87-K-00001)
(DE90-015312; LBL-28788-Extd-Abst; CONF-900877-5) Avail: NTIS HC/MF A02

Recent developments in the TEM Fresnel-fringe technique have provided an alternative method to the determination of structures and morphology of interfaces in multilayer thin film structures. This method has been employed in the investigation of structures and defects in grain boundaries, dislocations, precipitate platelets, twin boundaries, metal interfaces, and multilayer structures. It has been demonstrated that the fringe spacing primarily relates to the layer thickness, while the fringe contrast as a function of defocus relates to the magnitude of the localized change in the scattering potential and thus, to the interfacial composition. The profile of the fringes is more closely related to the abruptness of the composition change at the interface. Other factors affecting the Fresnel fringe intensity are the specimen thickness, aperture size, beam convergence, and degree of tilt of the interface from the incident electron beam. This paper discusses this technique further. GRA

**N91-20924#** Atomic Energy Commission, Damascus (Syria).
**PREPARATION AND CHARACTERISATION OF LaBaCaCu3O(x) AND La(1.3)Ba(1.7)Cu3O(x)**
S. Takriti, B. Ulug, P. Stastny, F. Mechdadi, A. Poddar, T. Placskowski, and O. Ares Jul. 1990 14 p Presented at the Experimental Workshop on High Temperature Superconductors and Related Materials, Trieste, Italy, 12 Mar. 1990
(DE91-615673; AECS-C/SS-15; CONF-9003236) Avail: NTIS HC/MF A03

An important subject for understanding the mechanism of high temperature superconductivity is the investigation of the substituted compounds of the 123 system. A new superconductor compounds have been prepared by solid state reaction from the stochiometric amounts of oxide and carbonite materials. Crystal structures were found to be tetragonal for both samples, and the electrical resistivity data obtained by the four probe technique. LaCaBaCu3O(7.1) sample reached zero resistivity at 83 K, while La(1.3)Ba(1.7)Cu-3O(7.1) sample reached zero resistivity at 33 K and it has almost metallic behavior. DOE

**N91-20925#** Aerospace Corp., El Segundo, CA. Lab. Operations.
**THE ROLE OF ACCEPTOR DENSITY ON THE HIGH CHANNEL CARRIER DENSITY I-V CHARACTERISTICS OF AlGaAs/GaAs MODFETs**
Richard J. Krantz and Walter L. Bloss 19 Oct. 1990 23 p
(Contract F04701-88-C-0089)
(AD-A229953; ATR-0090(5925-01)-1; SSD-TR-90-45) Avail: NTIS HC/MF A03 CSCL 20/12

A triangular-well, one-subband depletion layer model has been developed for the high density region of a modulation doped field-effect transistor (MODFET). High density operation is defined as operation when the channel carrier density, in the entire channel, is equal to or greater than m(sub l)kT/(pi x h(exp 2)). This high density model has been used to describe the effects of the depletion layer charge on the I-V characteristics. An approximation for the experimentally determined threshold voltage is derived. For small acceptor densities, approximately 10(exp 13)/cc, it is shown that the experimentally determined threshold voltage may differ from the strong inversion threshold voltage by 0.25 V. We show that this discrepancy is due to the effect of the depletion layer charge in the high density region. Also, the depletion layer

charge is shown to account for the discrepancy in the device capacitance and the AlGaAs layer capacitance. The effective layer thickness delta is shown to decrease from 90 A at an acceptor density of 10(exp 13)/cc to 75 A at 10(exp 17)/cc. GRA

**N91-20926#** Universidad Politecnica de Madrid (Spain). Dept. de Ingenieria Electronica.
**ELECTRICAL BEHAVIOR ON n-TYPE DOPANTS IN AlGaAs ALLOYS: SHALLOW LEVELS AND DX CENTERS Final Report, 15 Sep. 1988 - 14 Sep. 1990**
Elias Munoz Nov. 1990 131 p
(Grant AF-AFOSR-0316-88)
(AD-A229957; EOARD-TR-91-01) Avail: NTIS HC/MF A07 CSCL 20/12

The electrical properties of n-type Al(x)Ga(1-x)As are governed by deep donor states, formerly called DX centers, and created by the isolated donor atoms. At very low Al compositions, such deep donors become resonant with the gamma minimum. For GaAs compositions, the electron thermal emission was studied under hydrostatic pressure. It is suggested that deep donors show a discrete structure of energy levels, revealed in their thermal emission kinetics. An analysis of the capacitance behavior of AlGaAs n-type regions (x greater than 0.2) was performed for Si and Sn donors. Electron capture kinetics was modeled. GRA

**N91-20927#** State Univ. of New York at Buffalo, Amherst.
**LIGHT-INDUCED DRIFT OF QUANTUM-CONFINED ELECTRONS IN SEMICONDUCTOR HETEROSTRUCTURES**
Mark I. Stockman, Lakshmi N. Pandey, and Thomas F. George Dec. 1990 16 p
(Contract N00014-90-J-1193)
(AD-A229959; UBUFFALO/DC/90/TR-33) Avail: NTIS HC/MF A03 CSCL 09/1

The effect of light-induced drift of quantum-confined electrons in semiconductor heterostructures is predicted. The effect manifests itself as the electric current in the heterostructure plane in response to optical excitation with the frequency close, but not exactly equal, to a transition frequency between levels in the heterostructure. The current reverses its direction with a change in the detuning sign, and vanishes if the radiation polarization is normal to the heterostructure plane. GRA

**N91-20928#** Spire Corp., Bedford, MA.
**MOCVD OF LEAD-GERMANATE FOR NON-VOLATILE RAMs, PHASE 1 Final Report**
Anton C. Greenwald 1990 18 p
(Contract N00014-90-C-0127)
(AD-A230014; FR-60173-Phase-1) Avail: NTIS HC/MF A03 CSCL 09/1

The goal was to fabricate thin film ferroelectric materials for use in non-volatile random access memory (NVRAMs) chips that are radiation resistant and can be used to replace existing memories with the same function in current Navy systems at great savings in weight and power requirements. Suitable non-volatile memories have been demonstrated using ferroelectric materials to store the information in binary code as the direction of polarization of the dielectric. However, these memories have not yet demonstrated adequate retention or cycle lifetime (fatigue) to be used in practical applications. Research is progressing to identify the flaws in existing technology and to explore alternate materials and fabrication methods to extend the fatigue of NVRAMs. Phase 1 technical objectives were (1) to deposit a thin film of lead-germanate (PGO) with the correct stoichiometry and low levels of contaminants by metalorganic chemical vapor deposition (MOCVD), and (2) to deposit a similar film on a metal substrate, fabricate a capacitor and measure electrical properties. MOCVD of lead germanate has never been reported prior to this work. Objective (1) was achieved, the fabrication of stoichiometric lead-germanate films, and the capacitors required for objective (2) was fabricated. GRA

**N91-20929#** Texas Instruments, Inc., Dallas. Central Research Labs.
**SELECTIVE HETEROEPITAXIAL GROWTH OF COMPOUND SEMICONDUCTORS Final Report, Aug. 1988 - Oct. 1990**
Edward Beam and Yung-Chung Kao 1 Nov. 1990 58 p
(Contract F49620-88-C-0106)
(AD-A230016; TI-08-90-53; AFOSR-90-1166TR) Avail: NTIS HC/MF A04 CSCL 09/1

The effect of reduced growth area on the lattice mismatch accommodation of In(x)Ga(1-x)As/GaAs and GaAs/Si grown by molecular beam epitaxy (MBE) has been studied with cross-sectional transmission electron microscopy (XTEM)and cathodoluminescence (CL). Results indicate that the use of step-composition grading and linear-composition grading are particularly effective when combined with reduced growth areas and In(x)Ga(1-x)As compositions up to x = 0.25. Blanket areas with the same composition grading techniques exhibited randomly distributed threading dislocation-free regions approximately 30 microns in diameter, which were bounded by high-density dislocation pile-ups. GRA

**N91-20930#** Rome Air Development Center, Griffiss AFB, NY.
**MEASUREMENT AND ANALYSIS OF THE MICROWAVE SURFACE RESISTANCE IN A MIXED PHASE Y-Ba-Cu-O SUPERCONDUCTOR**
John S. Derov, Peter J. Walsh, W. D. Cowan, C. VonBenken, and A. Drehman Mar. 1990 12 p
(AD-A230047; RADC-TR-90-45) Avail: NTIS HC/MF A03 CSCL 20/3

Absolute microwave surface resistance of a mixed-phased YBCO 88K superconductor has been measured at 16.5 GHz over the temperature range from 6 to 90 K. The data revealed at least 2 superconducting phases. A phase with lower transition temperature produces a residual surface resistance marked by a discontinuity in surface resistance versus temperature at 52 K. This phase is apparently closely related to the 60 K bulk YBCO superconductor. An additional resistance discontinuity occurs at 83 K. Thus, microwave surface resistance is a diagnostic tool for multiphase superconductors. With recognition that mixed superconducting phases act as added residual resistances, the Mattis-Bardeen theory gives a good fit to the superconducting surface resistance for both phases. GRA

**N91-20931#** Stanford Univ., CA. Physics Lab.
**SCANNING TUNNELING MICROSCOPY OF SEMICONDUCTOR SURFACES Technical Performance Report, 1 Oct. 1989 - 30 Sep. 1990**
J. Nogami and C. F. Quate Dec. 1990 8 p
(Contract N00014-90-J-1001)
(AD-A230064; SU-GL-4776) Avail: NTIS HC/MF A02 CSCL 20/5

This is a summary of the results during the first year of a research program aimed at studying the atomic structure of semiconductor surfaces using scanning tunneling microscopy (STM). This research has concerned epitaxial growth of metals on the (111) and the (100) surfaces of silicon, with particular emphasis on the Si(100) surface. We have studied In, Sn, and Sb on Si(100), and Au on Si(111), focusing on phenomena such as order and disorder in surface reconstructions, nucleation and growth, growth anisotropy, and rearrangement of the Si substrate step distribution. GRA

**N91-20932#** Stanford Univ., CA. Physics Lab.
**METAL-VACUUM-METAL TUNNELING Final Technical Report, 1 Sep. 1984 - 31 Aug. 1990**
C. F. Quate Nov. 1990 73 p
(Contract N00014-84-K-0624; ARPA Order 5190)
(AD-A230065; SU-GL-4766) Avail: NTIS HC/MF A04 CSCL 14/3

A program directed toward a study of the Scanning Tunneling Microscope (STM) as a new instrument for examining and modifying surfaces at the atomic level is discussed. The STM has been developed to the point where it can be used routinely to record

atomic surface structure and this technology has been successfully transferred to a commercial enterprise. The underlying technology can be used to mark surfaces on the scale of 100 A exploiting a variety of physical mechanisms. The writing speeds and signal-to-noise ratios in this new marking technology are suitable for high density storage systems. GRA

**N91-20933#** General Atomic Co., San Diego, CA.
**HIGH-TEMPERATURE CERAMIC SUPERCONDUCTORS Annual Report, 1 Oct. 1989 - 30 Sep. 1990**
K. S. Mazdiyasni 15 Nov. 1990 89 p
(Contract N00014-88-C-0714)
(AD-A230074; GA-A-20346) Avail: NTIS HC/MF A05 CSCL 20/3

The principal goals of this program are (1) to demonstrate fabrication of high-temperature ceramic superconductors via sol-gel method that can operate at or above 90 K with appropriate current density, J(sub c), in forms useful for application in resonant cavities, magnets, motors, sensors, computers, and other devices; and (2) to fabricate and demonstrate selected components made of these materials, including microwave cavities and magnetic shields. Chemical pathways for synthesis of 123 identified, process parameters window for sol-gel derived 123 fibers established, continuous flexible fibers 15 to 200 microns in diameter producted, fibers with T(sub c) is approximate or equal to 92.5 K, Delta T = 1.5 K, J(sub c) = 2000 A/sqcm at 77 K, 0 field; 4000 at 57K, 100 Oe was produced, formed adherent 123 oriented films on metals and ceramic substrates, achieved film T(sub c) is approximate or equal to 92 K, Delta T = 4 k, J(sub c) = 400 A/sq cm at 40 K, O field. GRA

**N91-20934#** Minnesota Univ., Minneapolis. Dept. of Chemical Engineering and Materials Science.
**CORRELATION OF ELECTRON-TRANSFER RATES WITH THE SURFACE DENSITY OF STATES OF NATIVE AND ANODICALLY GROWN OXIDE FILMS ON TITANIUM Technical Report, 1 Jan. - 31 Oct. 1990**
Norberto Casillas, Shelly R. Snyder, William H. Smyrl, and Henry S. White 16 Nov. 1990 22 p
(Contract N00014-87-K-0494)
(AD-A230101; TR-14-ONR) Avail: NTIS HC/MF A03 CSCL 20/12

We report tunneling spectroscopy (TS) and surface density of states (SDOS) plots ((dI/dV)/(IV) vs V) for native and anodically grown titanium dioxide (TiO2) film on polycrystalline Ti. The results are compared to data obtained using single crystal TiO2, 001 and 110, surface orientations. SDOS plots for anodically grown TiO2 films (160A thick) and single crystal TiO show a large band-gap region (approx. 2eV) with a low state density separating the conduction and valence band edges. The similarity in the distribution of SDOS for anodically grown film has a well-ordered rutile structure. In contrast, SDOS plots obtained on native TiO2 films show a nearly constant density of states over a 5 eV range and a approx. 25-fold increase in state density at energies corresponding to the band-gap region of anodically grown films and single crystal TiO2. Electrontransfer rates for the oxidation of ferrocene in acetonitrile at native and anodically grown TiO2 films are reported and correlated with the measured SDOS of these materials. GRA

**N91-20935#** Virginia Univ., Charlottesville. Dept. of Electrical Engineering.
**SIS MIXER RESEARCH Final Technical Report, 1 Feb. 1989 - 13 May 1990**
Arthur W. Lichtenberger and Marc J. Feldman Nov. 1990 13 p
(Grant AF-AFOSR-0233-89; AF Proj. 2305)
(AD-A230167; UVA/525704/EE91/101; AFOSR-90-1179TR)
Avail: NTIS HC/MF A03 CSCL 09/1

Theoretical and experimental research has been conducted to elucidate the basic physics behind the properties of 'superconductor insulator superconductor' (SIS) tunnel junction receiving devices. The properties of an SIS mixer using a slightly nonideal junction, with finite Local Oscillator (LO) power, were determined by analytic expansion of the equations of the quantum theory of mixing. The resulting equations have a particularly simple form. The minimum noise temperature is controlled by the leakage current of the junction. Even the most nearly ideal junctions made today require a considerable LO for best sensitivity; nevertheless, even a comparatively large leakage current allows mixer noise to be only a small factor above the quantum limit. The saturation properties of SIS mixers subjected to broadband thermal noise obey the equations derived for monochromatic saturating signals. The Josephson junction tuning inductor was analyzed with the conclusion that such a device is not feasible with present fabrication techniques. Computer calculations using synthetic SIS junction I-V characteristics predicted the performance of an optimized receiver over its entire operating frequency range. Many aspects of the operation of SIS mixers were clarified and unexpected new phenomena were predicted. A 'photon picture' interpretation of the quantum theory of mixing is in the early stages of development. Niobium nitride edge junctions with excellent current-voltage characteristics were fabricated using novel barrier formation processes. GRA

**N91-20936#** Army Construction Engineering Research Lab., Champaign, IL.
**SELECTIVE SCREENING OF HIGH TEMPERATURE SUPERCONDUCTORS BY RESONANT EDDY CURRENT ANALYSIS Final Report**
Carl A. Feickert Nov. 1990 14 p
(AD-A230194; CERL-TR-M-91/09) Avail: NTIS HC/MF A03 CSCL 20/3

Electromagnetic shielding is often required in the design and construction of Army facilities and equipment to protect electrical systems or electronic components from the effects of unwanted electromagnetic energy. With the discovery of High Transition Critical Temperature Superconducting (HiTcS) compounds in 1987, researchers immediately sought electromagnetic applications for these novel materials. The purpose of this study was to develop an alternate screening analysis to supplement the traditional resistive methods of assessing HiTcS compounds' practically for electromagnetic applications. This report sets forth both the principle and practice of Resonant Eddy Current Analysis (RECA) and its applicability as a screening agent for prospective High Temperature Superconductors. The RECA methodology can provide an accurate measure of a sample's bulk critical density. It is inexpensive, requiring only an inductor, several capacitors, and an impedance meter. Its high intrinsic sensitivity can be maximized. The method provides a definitive signature unique to superconductors undergoing a magnetic phase transition. It does not require the conducting regions of a given sample to be contiguous and can provide valuable sample quality information for properly thermostated samples. GRA

**N91-20937#** Stanford Univ., CA.
**PROCEEDINGS OF AN INTERNATIONAL CONFERENCE ON ORGANIC SUPERCONDUCTORS Final Report, 1 Oct. 1989 - 30 Nov. 1990**
William A. Little 30 Nov. 1990 75 p Proceedings held in South Lake Tahoe, CA, 20-24 May 1990
(Contract N00014-90-J-1384)
(AD-A230241) Avail: NTIS HC/MF A04 CSCL 20/3

This is a report on the International Conference on Organic Superconductors which was held on May 20 to 24, 1990, at Fallen Leaf Lake, South Lake Tahoe, California. Sixty participants attended the conference from Japan, Europe, Canada, and the United States, and over forty papers were presented on recent developments in the field and reviews were given on the optical, thermo-electric, and the fermiological properties of organic conductors. A distinguished panel of experts discussed the prospects and the means for synthesizing new classes of conducting and superconducting organics. GRA

**N91-20938#** North Carolina State Univ., Raleigh. Dept. of Materials Science and Engineering.
**PSEUDOMORPHIC SEMICONDUCTING HETEROSTRUCTURES FROM COMBINATIONS OF AIN AND GaN AND SELECTED SiC POLYTYPES: THEORETICAL ADVANCEMENT AND ITS COORDINATION WITH EXPERIMENTAL STUDIES OF NUCLEATION, GROWTH, CHARACTERIZATION AND DEVICE DEVELOPMENT**
Robert F. Davis, Max W. Braun, Larry Rowland, Zlatko Sitar, and Andrej Skerlavaj Dec. 1990 46 p
(Contract N00014-90-J-1427)
(AD-A230268) Avail: NTIS HC/MF A03 CSCL 09/1

In this reporting period, research has been conducted in three primary areas: (1) development and application of computer codes concerned with the prediction of properties of pseudomorphic structures; (2) the growth of GaN/AlN pseudomorphic structures; and (3) the construction of a growth system for the deposition of SiC/AlN/GaN pseudomorphic structures. The van der Merwe-Reiss rigid model has been extended theoretically via computer algorithms for polyatomic systems by allowing several interaction potentials to act simultaneously between overgrowth atoms and the substrate across planar interfaces. These adaptations have also been applied to an extended model which includes homogeneous strain and thickness. In this latter model, epitaxial orientations are predicted to be those which minimize strain and misfit energies together. Experimentally, AlN/GaN layered structures have been grown using a modified gas source MBE for the growth of SiC/AlN/GaN pseudomorphic layers is being constructed, it is described in detail. GRA

**N91-20939#** North Carolina State Univ., Raleigh. Dept. of Materials Science and Engineering.
**GROWTH, NITROGEN VACANCY REDUCTION AND SOLID SOLUTION FORMATION IN CUBIC GaN THIN FILMS AND SUBSEQUENT FABRICATION OF SUPERLATTICE STRUCTURES USING AlN AND InN Annual Letter Report, 1 Jan. - 31 Dec. 1990**
Robert F. Davis, Michael J. Paisley, and Zlatko Sitar Dec. 1990 59 p
(Contract N00014-86-K-0686)
(AD-A230269) Avail: NTIS HC/MF A04 CSCL 09/5

In the research of this reporting period, AlN films and AlN/GaN layered structures have been grown and structurally, chemically and optically characterized. In addition, BN has been similarly deposited on cubic beta-SiC and diamond substrates. Strained layer superlattices have been fabricated for the first time between GaN and AlN. The energy offset was up to 260 meV for the superlattices with the thinnest barriers. A system for atomic layer epitaxy of GaN and AlN has been designed and is under construction. Cubic BN was deposited on the aforementioned substrates; however, significant carbon was also present. The latter problem has now been resolved. Laser ablation of hexagonal BN was also studied; however, only amorphous, wurtzite, and hexagonal (graphitic) BN was detected in the films. GRA

**N91-20940#** Lasergenics Corp., San Jose, CA.
**SINGLE CRYSTAL FIBERS OF MgO:LiNbO3 Final Report, 29 Jun. - 7 Aug. 1990**
Richard G. Schlecht 7 Aug. 1990 43 p
(Contract F49620-88-C-0084)
(AD-A230277; AFOSR-90-1189TR) Avail: NTIS HC/MF A03 CSCL 20/6

As optical instruments and devices see a broader and wider use, it becomes necessary to increase their efficiency in order to make them more compact and lighter, particularly for space applications. Nonlinear optical devices, such as second harmonic generators and parametric oscillators, will be an important part of this in order to create new wavelengths and tunable sources. If these devices can be made in fiber form, a significant improvement in efficiency will result. It will then be possible to use the efficient semiconductor lasers as a pump in spite of their poor beam quality. We have investigated the growth of MgO:LiNbO3 in fiber form using the laser-heated pedestal-growth technique. We were able to grow fibers of good optical quality without resorting to post-growth processing. However, we did anneal the fibers to improve their mechanical properties. Different techniques were tried to pole the fibers with limited success. GRA

**N91-20941#** California Univ., Berkeley. Sponsored Projects Office.
**MAGNETIC RESONANCE OF DEFECTS IN HETERO-EPITAXIAL SEMICONDUCTOR STRUCTURES Annual Report, 15 Apr. 1989 - 14 Apr. 1990**
Eicke R. Weber 4 Apr. 1990 11 p
(Grant AF-AFOSR-0162-88; AF Proj. 2305)
(AD-A230281; AFOSR-90-1181TR) Avail: NTIS HC/MF A03 CSCL 09/5

Research in the reporting period was concentrated on the continuation of a pioneering study of the defects present in thin film GaAs grown by MBE at temperatures between 190 and 300 C. These layers have attracted recently great interest as buffer layers for the suppression of sidegating between MESFET devices and as active layers for ultrafast photodetectors working in the sub-picosecond range. A comprehensive analysis by magnetic resonance, infrared absorption, Hall effect, x-ray diffraction and particle-induced x-ray emission showed that the transport in these very As-rich layers is dominated by a hitherto unknown kind of hopping conduction between localized arsenic antisite defects present in concentrations up to 10(exp 20)/cu cm and partly compensated by up to 10(exp 18)/cu cm acceptors. The total concentration of excess As reached values of 6 x 10(exp 20)/cu cm, corresponding to AsGa = 1.03. This was found together with a lattice expansion of up to 0.15 percent. Thermal annealing to temperatures higher than 500 C resulted in disappearance of the lattice expansion, a reduction of the antisite defect concentration by at least two orders of magnitude, and the disappearance of hopping conduction. Optically detected magnetic resonance (ODMR) experiments using luminescence emission were successfully implemented, but the luminescence of low-temperature grown GaAs turned out to be too small for detection by ODMR. GRA

**N91-20942#** Illinois Univ., Champaign.
**PLASMA ENHANCED GAS SOURCE MOLECULAR BEAM EPITAXY DEPOSITION OF HIGH QUALITY GaN Annual Letter Report, 1 Oct. 1989 - 30 Sep. 1990**
Hadis Morkoc 30 Sep. 1990 17 p
(Contract N00014-89-J-1780)
(AD-A230345) Avail: NTIS HC/MF A03 CSCL 20/12

GaN is a III-V semiconductor with enormous optical device potential in the near ultraviolet region, a band which has been relatively inaccessible to semiconductor technology. High quality GaN, along with its AlN and InN alloys, would make feasible the production of optically active devices ranging from the visible out to the approximately 6 eV band gap of AlN. Along with its potential benefits come the challenges of this material system. Researchers in the past have been plagued by the inertness of nitrogen which causes GaN films to have a high n-type background carrier concentration resulting from nitrogen vacancies. The goal is to apply electron cyclotron resonance plasma and molecular beam epitaxy technology towards the GaN problem to obtain device quality semiconductor material. With the growth of high quality cubic GaN this past year, our program has defined itself into two main objectives. Further optimization of the GaN deposition to obtain material of the highest optical and electronic quality will be necessary. Parallel efforts will be undertaken in the related AlN and InN systems. The ability to grow each material will allow these materials to be combined into heterostructure devices analogous to those common in other compound semiconductor systems. A second avenue of activity which can be explored in parallel with the device work will be a cataloging of the properties of the entirely new cubic phases of GaN, InN and AlN. Cubic InN and AlN have never to our knowledge been produced in a laboratory. Comparison of the physical properties of these materials with the established properties of the wurtzite phases would yield

interesting insights into the role of crystal structure and its influence on the solid state. GRA

**N91-20943#** California Univ., Santa Barbara. Dept. of Electrical and Computer Engineering.
**NEW KINDS OF QUANTUM WELLS Annual Report No. 1, 1 Dec. 1989 - 30 Nov. 1990**
Herbert Kroemer 27 Dec. 1990 20 p
(Contract N00014-90-J-1413)
(AD-A230346) Avail: NTIS HC/MF A03 CSCL 20/12

The research concentrated almost exclusively on the InAs/AlSb quantum well system, with some supporting work on the GaSb/AlSb system. Many advances were made. The overall quality of the quantum wells improved, now routinely yielding room-temperature mobilities of 30,000 sq cm/Vs for 15 nm wide wells. A new two-donor model explains the electron concentrations, in terms of a deep EL2-like bulk donor and a mysterious interface donor near the bottom of the well, below the lowest quantum state. A first systematic study of transport properties vs. well widths was undertaken, showing a steep drop in mobility for well widths below 10 nm. Cyclotron resonance data taken at the University of Munich give quantitative evidence of non-parabolicity under the combined effect of quantization and band filling. Field effect transistors and photoluminescence data continue to present difficulties. Tilted superlattices (TSL's) from the GaSb/AlSb system were demonstrated, with very promising properties, as were InAs quantum wells that incorporate GaSb/AlSb TSLs either as corrugated barriers or as periodic center loading. A record electron mobility for InAs (613,000 sq cm/Vs) was obtained in the corrugated barrier well. GRA

**N91-20944#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
**SOLID STATE RESEARCH Quarterly Technical Report, 1 Feb. - 30 Apr. 1990**
Alan L. McWherter 15 May 1990 83 p
(Contract F19628-90-C-0002)
(AD-A230358; Rept-1990:2; ESD-TR-90-087) Avail: NTIS HC/MF A05 CSCL 09/5

The research work of the Solid State division at Lincoln Laboratory for the period of February 1 through April 30, 1990 is covered. The topics covered include: electrooptical devices, quantum electronics, materials research, submicrometer technology, microelectronics, and analog device technology. GRA

**N91-20945#** Illinois Univ., Urbana.
**NOVEL HIGH SPEED DEVICES AND HETEROSTRUCTURES PREPARED BY MOLECULAR BEAM EPITAXY Letter Report, 1 Oct. 1989 - 30 Sep. 1990**
H. Morkoc 30 Sep. 1990 19 p
(Contract N00014-86-K-0513)
(AD-A230389) Avail: NTIS HC/MF A03 CSCL 20/12

The research funded the following projects - Metal-Insulator-Semiconductor Field-Effect Transistor (MISFET), Ge/GaAs Heterojunction Bipolar Transistor (HBT), power HBT, and a theoretical investigation on Direct and Resonant Tunneling Diode (RTD). This project investigated the properties of MISFET type structures based on compound semiconductors. MISFET's have advantages over the aforementioned transistors in areas where high speed, simplicity of fabrication, uniformity of threshold voltages, low standby power, and high gate operational voltages are required. A major research goal is to investigate Ge/GaAs heterojunctions towards incorporating Ge in well established GaAs Heterojunction Bipolar Transistors (HBT's). This novel material combination will result in enhanced device performance. For HBT's, critical parameters affecting the device performance are base doping, base contact resistance, and band discontinuities at the emitter base junction. The semiconductor Ge has excellent potential to improve the performance of GaAs/AlGaAs HBT's. The third investigates the current handling capability of AlGaAs/GaAs HBT's. The idea is to use the HBT as a high-power and high-speed device. Multi-finger emitter and emitter ballasting resistor are used in the design of the HBT. The direct and resonant tunneling diode project used a k dot p band model to calculate the complex wave-vectors of the tunneling electrons in the calculation of the I-V characteristics of these types of diodes. GRA

**N91-20946#** University Coll., Cardiff (Wales). Dept. of Physics.
**AN XPS STUDY OF THE FORMATION OF ULTRATHIN PLATINUM AND IRIDIUM SILICIDE LAYERS ON Si(100) AND Si(110) SURFACES Final Report, 1 Sep. 1989 - 30 Sep. 1990**
S. J. Morgan and R. H. Williams Nov. 1990 22 p
(Grant AF-AFOSR-0377-87; AF Proj. 2301)
(AD-A230391; EOARD-TR-91-02) Avail: NTIS HC/MF A03 CSCL 20/12

The formation of thin (5-100 A) platinum and iridium silicide films on the clean Si(100)2x1 surface has been studied using X-Ray Photoelectron Spectroscopy. A detailed analysis of the Si 2p and Pt/Ir 4f core-level photoemission lineshapes and intensities has allowed the determination of the phase formation sequence, and the resulting change in Schottky barrier height, with annealing. Progressively silicon rich silicides were formed with increasing temperature, at temperatures greater than 600 C this process was limited by rapid surface segregation of silicon atoms from the substrate. Small changes in relative Schottky barrier height were observed for different silicide phases, with the monosilicide phases giving the lowest Schottky barriers. GRA

**N91-20947#** Stanford Univ., CA. Lab. of Physics.
**SUPERCONDUCTIVITY AND SUPERCONDUCTIVE ELECTRONICS Annual Report, 15 Oct. 1989 - 14 Oct. 1990**
M. R. Beasley Dec. 1990 19 p
(Contract F49620-89-C-0001)
(AD-A230409; AFOSR-90-1205TR) Avail: NTIS HC/MF A03 CSCL 20/12

The Stanford Center for Research on Superconductivity and Superconductive Electronics is currently focused on developing techniques for producing increasingly improved films and multilayers of the high-temperature superconductors, studying their physical properties and using these films and multilayers in device physics studies. In general the thin film synthesis work leads the way. Once a given film or multilayer structure can be made reasonably routinely, the emphasis shifts to studying the physical properties and device physics of these structures and on to the next level of film quality or multilayer complexity. The most advanced thin films synthesis work in the past year has involved developing techniques to deposit a-axis and c-axis YBCO/PBCO superlattices and related structures. The in-situ feature is desirable because no solid state reactions with accompanying changes in volume, morphology, etc., that degrade the quality of the film involved. GRA

**N91-20948#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**LOW TEMPERATURE PHOTOLUMINESCENCE STUDY OF HOLMIUM AND THULIUM IMPLANTED INTO 3-5 SEMICONDUCTORS AND SILICON M.S. Thesis**
Eric Silkowski Dec. 1990 86 p
(AD-A230424; AFIT/GEP/ENP/90D-7) Avail: NTIS HC/MF A05 CSCL 20/6

Low temperature photoluminescence studies were performed on holmium implanted into InP, GaAs, and Si; and thulium implanted into AlGaAs, GaAs, and Si. Samples were annealed by the conventional furnace and rapid thermal techniques. None of the characteristic 4f emissions of holmium were found in the spectral region of 0.73 to 1.55 eV. AlGaAs:Tm showed strong thulium emissions in the .93 to 1.03 eV region. These emissions were studied and compared to those in GaAs:Tm. Low and high temperature annealed samples showed evidence of trivalent Tm centers. Temperature dependence studies showed that thulium 4f emissions were present above 200 K but quench by 240 K. Laser excitation power dependence studies showed that the luminescent intensity of the main thulium 4f line depends linearly on the square root of laser power. This result implies that non-radiative decay mechanisms complete with the excitation and subsequent radiative

decay of the thulium 4f shell. Also observed for the first time were thulium 4f emissions in the 0.93 to 1.03 eV region in high purity silicon implanted with thulium. GRA

**N91-20949#** Westinghouse Electric Corp., Baltimore, MD. Advanced Technology Div.
**WESTINGHOUSE SUPERCONDUCTING IR FOCAL PLANE ARRAY**
Arthur S. Jensen 10 Oct. 1990 1 p
(Contract SDIO84-88-C-0042)
(AD-A229652; SDIO-N-1504) Avail: NTIS HC/MF A01 CSCL 20/12

Work to be performed includes research on LTS circuits for IR detector arrays; research on HTS IR focal plane arrays, their construction and behavior; demonstration of SC A/D circuit with photodiode signal current source; and demonstration of the operation of an IR imaging system using SC A/D circuits. GRA

**N91-20950#** Defence Research Establishment, Ottawa (Ontario).
**AN EXAMINATION OF RADIATION-INDUCED BIT-UPSET PATTERNS IN SEMICONDUCTOR MEMORIES**
T. Cousins and E. L. Karam May 1990 45 p
(AD-A229659; DREO-1038) Avail: NTIS HC/MF A03 CSCL 20/12

The interaction of photon radiation with semiconductor memories is well known to cause errors in the memory contents by a bit-flap process. Using a MOSAID MS2200 memory tester system, experiments were carried out to determine the number and location of these errors for two Dynamic Random Access Memories (DRAMs) and one Semiconductor Random Access Memory (SRAM) exposed to LINAC and 60Co sources. The results showed that the errors are not, in general, randomly located and are highly dependent on chip architecture. This is particularly true for the DRAMs where the bits adjacent to decoder and ground lines were observed to be the first to flip. GRA

**N91-20951#** Ghent Univ. (Belgium).
**THICKNESS VARIATIONS DURING MOVPE GROWTH ON PATTERNED SUBSTRATES**
L. Buydens, P. Demeester, M. VanAckere, A. Ackaert, and P. V. Daele 1990 5 p
(Contract DAJA-90-C-0003)
(AD-A229685) Avail: NTIS HC/MF A01 CSCL 20/2

Experiments have been carried out to investigate thickness variations between epitaxial layers grown on ridges or channels and the surrounding planar surface. Results show a remarkable variation in growth velocity, even for relatively wide channels and ridges. Using these findings, a novel laser/waveguide coupling technique, which uses a single epitaxial growth step, is proposed. GRA

**N91-20952#** Minnesota Univ., Minneapolis. Dept. of Chemical Engineering and Materials Science.
**IMAGING OF STACKING FAULTS IN HIGHLY ORIENTED PSROLYTIC GRAPHITE USING SCANNING TUNNELING MICROSCOPY Technical Report No. 16, 1 Jan. - 31 Oct. 1990**
Shelly R. Snyder, T. Foecke, Henry S. White, and W. W. Gerberich 3 Dec. 1990 14 p
(Contract N00014-87-K-0494)
(AD-A229776) Avail: NTIS HC/MF A03 CSCL 11/2

Scanning tunneling microscopy images of the (0001) plane of highly oriented pyrolytic graphite show defect regions consisting of an extensive network of partial dislocations that form extended and contracted nodes. The partial dislocations in hexagonal graphite enclose triangular regions (about 1000 nm on a side) of faulted material comprised of rhombohedral graphite. Tunneling spectroscopy shows differences in the dependence of the tunneling current on voltage between the faulted and unfaulted regions. Electronic and elastic interactions of the tip with the HOPG surface are proposed to explain the observed image contrast between hexagonal and rhombohedral graphite. GRA

**N91-20953#** State Univ. of New York, Buffalo. Dept. of Chemistry.
**POSITION EXPECTATION VALUE AND OSCILLATOR STRENGTH OF A BIASED ASYMMETRIC QUANTUM WELL**
Lakshmi N. Pandey and Thomas F. George Dec. 1990 25 p
(Contract N00014-90-J-1193)
(AD-A229803; UBUFFALO/DC/90/TR-31) Avail: NTIS HC/MF A03 CSCL 20/12

The change in the position expectation values of an electron in the first three quasibound states of the structure as a function of the external (biased) voltage is calculated. At the resonance voltage, the most probable position to find an electron in the second and third quasibound states lies in the barrier separating the two wells, and these two states interchange their identities, meaning that the ground state of the narrow well becomes the first-excited state of the wide well and vice versa. GRA

**N91-20954#** Cambridge Univ. (England).
**PROCESSING OF MIXED OXIDE SUPERCONDUCTORS Final Report, Dec. 1987 - Jul. 1990**
A. M. Campbell and M. F. Ashby Jul. 1990 74 p
(Contract DAJA45-87-C-0059; DA Proj. 1L1-61102-BH-57)
(AD-A229845) Avail: NTIS HC/MF A04 CSCL 20/3

This work was initiated soon after the discovery of high temperature superconductors. Although much effort was being put into the research for higher temperature materials, it rapidly became clear that the main obstacle to the application of these materials was the low critical current density. Although in conventional materials the critical current density was determined by the pinning of flux lines by defects in the microstructure in high Tc materials, the appearance of weak links, or Josephson Junctions, at grain boundaries was the dominant effect. This was a completely new phenomena and led not only to rather low critical current densities in zero field but to a catastrophic drop in fields of only a few millitesla, although the upper critical field of these materials is extremely high (probably greater than 150 Tesla). The work can be divided into four main sections: magnetic separation; levitation; screening; and critical current studies. GRA

**N91-20955#** California Univ., San Diego, La Jolla.
**SOURCES OF ANISOTROPY IN AMORPHOUS MAGNETIC THIN FILMS Annual Report, 1 Jul. 1989 - 31 Jul. 1990**
Frances Hellman 17 Nov. 1990 6 p
(Grant AF-AFOSR-0432-89; AF Proj. 2306)
(AD-A230542; AFOSR-90-1224TR) Avail: NTIS HC/MF A02 CSCL 09/1

With the assistance of this grant, my laboratory has progressed substantially and is now beginning to produce results. This last year, in addition to lab build-up and student supervision, I have continued work on the amorphous rare earth transition metal alloys. There are several significant new results arising from this work. A model for the growth-induced macroscopic magnetic anisotropy: I have clear evidence against Takeshi Egami's bond-orientational anisotropy model which attributes the anisotropy to anelastic strain. He describes this model as a simple increase in the number of bonds in-plane compared to out-of-plane due to stress during the growth. I find a strong (more than an order of magnitude) dependence of the anisotropy on deposition temperature and essentially no dependence on the state of stress either during the growth or after. I believe the reason for the anisotropy is a texturing of the short-range order relative to the surface, which minimizes surface energy at every instant during the growth, and gets frozen into the structure. GRA

**N91-20956#** Martin Marietta Space Systems, Inc., Denver, CO.
**RANDOM LOGIC OXIDE SCREENING METHODS Final Report, Sep. 1987 - Jan. 1990**
Douglas N. Krening Dec. 1990 245 p
(Contract F30602-87-C-0138)
(AD-A230579; MCR-90-504; RADC-TR-90-314) Avail: NTIS HC/MF A11 CSCL 09/1

This report covers the work performed on the Random Logic Oxide Screening Methods study in which techniques were

investigated to improve oxide reliability screening methods in CMOS random logic devices. This effort included modeling of time dependent dielectric breakdown in state-of-the-art gate oxides, development of both internal and external screening techniques, and the performance of a screen and accelerated life test to verify predicted screening effects. GRA

**N91-20957#** Illinois Univ., Urbana.
**GaAs/AlGaAs ELECTRONICS AND InGaAs(P) OPTOELECTRONICS ON InP SUBSTRATES BY GAS SOURCE MBE Letter Report, 1 Oct. 1989 - 30 Sep. 1990**
H. Morkoc 30 Sep. 1990 15 p
(Contract N00014-88-K-0724)
(AD-A230622) Avail: NTIS HC/MF A03 CSCL 09/1

The research goals are to design and implement novel schemes in order to utilize the optical and electrical properties of III-V semiconductors devices grown by MBE and to enhance their performance. Intimately tied to this is the characterization of optical devices such as modulators, lasers, and detectors as well as an understanding of the underlying optical processes involved. GaAs based materials as well as InGaAs and InP material systems are investigated for possible optoelectronic integration. Specifically, by using Gas Source MBE (GSMBE), high quality InP based materials will be obtained as well as GaAs electronic devices grown of InP substrates. The latter being an initial step towards the optoelectronic integration of GaAs with InP. GSMBE provides excellent control over the AS/P ration which cannot be achieved by conventional solid source MBE. Utilization of this technique will lead to the realization of low threshold, low current density CW laser in InGaAsP material system. GRA

**N91-20958#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**ANALYSIS OF SPACE RADIATION EFFECTS IN GALLIUM ARSENIDE AND CADMIUM SELENIDE SEMICONDUCTOR SAMPLES USING LUMINESCENCE SPECTROSCOPIC TECHNIQUES M.S. Thesis**
Brad L. Shaffer Dec. 1990 120 p
(AD-A230684; AFIT/GSO/ENP/90D-02) Avail: NTIS HC/MF A06 CSCL 07/4

Analysis of space radiation effects in gallium arsenide and cadmium selenide semiconductor samples using luminescence spectroscopic techniques. The M0006 semiconductor samples were placed into a 28.5 degree inclination, 480 km altitude, near-circular orbit aboard the Long Duration Exposure Facility satellite and exposed to direct space environment for a period of 11 months, and were shielded by 0.313 inches of aluminum for another 58 months. The samples were examined for changes using cathodoluminescence and photoluminescence in various wavelength regions from 0.5 to 1.8 microns. Samples were cooled to approximately 10 K in a vacuum of 10-8. GRA

**N91-20959#** State Univ. of New York, Buffalo. Dept. of Chemistry.
**CLUSTER CALCULATION OF CuO2 IN HIGH-Tc SUPERCONDUCTORS**
H. R. Lee, Ki-Soo Sohn, and Thomas F. George Jan. 1991 15 p
(Contract N00014-90-J-1193)
(AD-A230758; UBUFFALO/DC/91/TR-39) Avail: NTIS HC/MF A03 CSCL 20/3

The eigenvalues of a small cluster in the CuO2 plane are obtained by exactly diagonalizing the extended Hubbard Hamiltonian. The eigenenergy spectrum is used for the grand partition function. The magnetic and thermodynamic quantities such as the magnetic susceptibility and specific heat are calculated with different occupation numbers and discussed in terms of the excited states of the system. GRA

**N91-20960#** Palisades Inst. for Research Services, Inc., NY.
**EXTENDED ABSTRACTS. THE US WORKSHOP ON THE PHYSICS AND CHEMISTRY OF MERCURY CADMIUM TELLURIDE AND NOVEL IR DETECTOR MATERIALS Final Report**
Mark Goldfarb Oct. 1990 188 p Workshop held in San Francisco, CA, 2-4 Oct. 1990
(Grant DAAL03-90-G-0202)
(AD-A230804; ARO-27876.1-EL-CF) Avail: NTIS HC/MF A09 CSCL 20/12

Reports are presented which were given at the workshop. Some topics which were discussed are: Diffusion Mechanisms in Mercury Cadmium Telluride; Selective Annealing for Planar Processing of HgCdTe Devices, The Effect of Growth Orientation on the Morphology, Composition, Twin Formation and Growth Rate of MCT Layers Grown by MOVPE, Low Dislocation Density HgCdTe Grown on GaAs and Si Substrates by MBE, Molecular Beam Epitaxy of CdTe on Large Area Si(100), Low Temperature Growth of MWIR LPE HgCdTE on Sapphire, Extrinsic Doping in MOCVD HgCdTe for Grown Junctions, Growth and Properties of In Doped MOVPE (IMP) HgCdTE, Dynamics of Arsenic Diffusion in OMVPE HgCdTe on Si Substrates, Growth and Characterization of P-on-n Heterojunction Material for 8 Micron to 18 Micron Applications, Improved Breakdown Voltage in MBE HgCdTe Heterostructures, Mercury Cadmium Telluride Epitaxially Grown Junctions, Dark Current Processes in Thinned P-Type HgCdTe, Uncooled 10.6 micron Mercury Manganese Telluride Photoelectromagnetic IR Detectors, Novel Device Concept for Silicon Based Infrared Detectors, Infrared Optical and Far-Infrared Magneto-Optic Properties of HgTe/CdTe Superlattices and Multiple Quantum Wells, Magneto-Optical Transitions Between Subbands with Different Quantum Numbers in Narrow GAP HgTe-CdTe Superlattices, Photoexcited Hot Electron Relaxation Processes In n-HgCdTe Though Impact Ionization Into Traps, and X Ray Photoelectron Diffraction From the HgCdTe (111) Surface. GRA

**N91-20961#** Laboratoire d'Automatique et d'Analyse des Systemes, Toulouse (France).
**SIMULATION OF HETEROPITAXIAL MULTILAYER GROWTH: FORMATION OF EXTENDED COLONIES AND DEFECTS M.S. Thesis - Toulouse Univ. [SIMULATION DE LA CROISSANCE HETEROEPITAXIQUE MULTICOUCHE: FORMATION DES AMAS ET DEFAUT ETENDUS]**
Mostefa Laroussi 1990 154 p In FRENCH; ENGLISH summary Sponsored by Centre National d'Etudes des Telecommunications
(LAAS-90404; ETN-91-98889) Avail: NTIS HC/MF A08

Heteropitaxial crystal growth is simulated using CdTe-GaAs crystals with a lattice mismatch of 14.6 percent. The formation growth and coalescence of colonies is studied. Temperature is shown to be an important parameter in the growth mechanism. Temperature also favors transition between dihedral and trihedral configuration precursors of an epitaxial layer orientation. An improved version of the SPARCC (French acronym for particulate layer growth simulator) software used in simulating the growth of two monolayers is described. ESA

**N91-20962#** Purdue Univ., West Lafayette, IN.
**MISCON: THE MIDWEST SUPERCONDUCTIVITY CONSORTIUM, PART 1 Progress Report**
A. I. Schindler Jan. 1991 11 p
(Contract DE-FG02-90ER-45427)
(DE91-008266; DOE/ER-45427/1-Pt-1) Avail: NTIS HC/MF A03

The Midwest Superconductivity Consortium has been established to address the materials related issues limiting the commercialization of high (Tc) superconductivity technology and in response to Congressional direction to create a new midwest superconductivity consortium. High (Tc) superconductor materials are of interest to the Department of Energy because they have the potential to impact strongly the energy related needs of this country. The Consortium brings together a demonstrated group of university personnel with talents in the areas critical to the needs

of understanding and developing these new superconductor materials. The charter membership of the Consortium includes Purdue University, University of Notre Dame, Indiana University, Iowa State University, University of Missouri and the Ohio State University, with the Consortium center being located at Purdue University. The management structure of MISCON consisting of both administrative and technical components has been established. The Director, and members of the Steering Committee and of the Program Committee have been selected. The Program Committee has selected two major research thrust areas for Consortium programs. Project proposals have been solicited and following an extensive review, fourteen projects were selected for funding. Work on these fourteen projects is now underway. DOE

**N91-20963#** Purdue Univ., West Lafayette, IN.
**MISCON: THE MIDWEST SUPERCONDUCTIVITY CONSORTIUM, PART 2**
A. I. Schindler Jan. 1991 38 p
(Contract DE-FG02-90ER-45427)
(DE91-008267; DOE/ER-45427/1-Pt-2) Avail: NTIS HC/MF A03

The Midwest Superconductivity Consortium has been established to address the materials related issues limiting the commercialization of high (Tc) superconductivity technology and in response to Congressional direction to create a new midwest superconductivity consortium. High (Tc) superconductor materials are of interest to the Department Energy because they have the potential to impact strongly the energy related needs of this country. The Consortium brings together a demonstrated group of university personnel with talents in the areas critical to the needs of understanding and developing these new superconductor materials. The charter membership of the Consortium includes Purdue University, University of Notre Dame, Indiana University, Iowa State University, University of Missouri and The Ohio State University, with the Consortium center being located at Purdue University. The management structure of MISCON consisting of both administrative and technical components has been established. The Director, and members of the Steering Committee and of the Program Committee have been selected. The Program Committee has selected two major research thrust areas for Consortium programs. Project proposals have been solicited and following an extensive review, fourteen projects were selected for funding. Work on these fourteen projects is now underway. DOE

**N91-20964#** Lawrence Livermore National Lab., CA.
**HRM INVESTIGATION OF THE STRUCTURE OF THE SIGMA 5(310)/ZONE AXES (001) SYMMETRIC TILT GRAIN BOUNDARY IN Nb**
W. E. King, A. Coombs, G. H. Campbell, and M. J Mills Nov. 1990 9 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 26-29 Nov. 1990
(Contract W-7405-eng-48)
(DE91-008571; UCRL-JC-106152; CONF-901105-101) Avail: NTIS HC/MF A02

Recent atomistic simulations using interatomic potentials for Nb developed employing the embedded atom method (EAM) and the model generalized pseudopotential theory (MGPT) have indicated a possible cusp at the Sigma 5(310) orientation in the energy vs. tilt angle curves for zone axes group 001 symmetric tilt grain boundaries. In addition, the most stable structure predicted using EAM exhibits shifts of one crystal relative to the other along the tilt axis and along the direction perpendicular to the tilt axis lying in the boundary plane. The structure predicted using the MGPT was mirror symmetric across the plane of the grain boundary. This boundary was n prepared for experimental study using the ultra high vacuum diffusion bonding methods. A segment of this boundary was studied using high resolution electron microscopy. DOE

**N91-20965#** Lawrence Livermore National Lab., CA.
**THE ELECTRONIC STRUCTURE OF GRAIN BOUNDARIES IN Nb**
E. C. Sowa, A. Gonis, and X. G. Zhang Nov. 1990 4 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 26-29 Nov. 1990
(Contract W-7405-eng-48)
(DE91-008572; UCRL-JC-106151; CONF-901105-99) Avail: NTIS HC/MF A01

First principles calculations are presented of the electronic structure of Nb grain boundaries. These are the first such calculations for a bcc metal using the real-space multiple-scattering theory (RSMST). Local densities of states near a Sigma 5 twist grain boundary are compared to those for bulk Nb. DOE

**N91-20966#** Los Alamos National Lab., NM.
**BOSONIC MECHANISM FOR HIGH-TEMPERATURE**
F. M. Mueller, G. B. Arnold, and J. C. Swihart (Indiana Univ., Bloomington.) 1991 13 p Presented at the Electronic Structure and Mechanisms for High Temperature Superconductivity, Coral Gables, FL, 3-9 Jan. 1991
(Contract W-7405-eng-36)
(DE91-008592; LA-UR-91-567; CONF-910145-1) Avail: NTIS HC/MF A03

The temperature dependent photoemission data of D. S. Dessau et al., show strong modulations in the superconducting state when compared to the normal state. These are similar to but larger than those seen historically in standard tunneling experiments in lower temperature superconductors. The Dessau data was analyzed using Nambu-Eliashberg theory assuming some (as yet unknown) boson exchange as the primary mechanism for the superconductivity. The derived alpha (sup 2)F's, lambda's and mu's show features which resemble those derived from inversions of other low temperature superconductors, albeit that lambda here is about 8.67 and mu is approx. 0.15. Several bosonic mechanisms are considered. DOE

**N91-20967#** Argonne National Lab., IL.
**DEFECTS, OXYGEN ORDERING AND PROPERTIES OF La-Cu-O AND Ba-Bi-O SUPERCONDUCTORS**
B. Dabrowski, Shiyou Pei, D. R. Richards, J. D. Jorgensen, D. G. Hinks, Y. Zheng, and A. W. Mitchell 1990 25 p Presented at the 26th Winter School of Theoretical Physics, Karpacz, Poland, 19 Feb. - 3 Mar. 1990
(Contract W-31-109-eng-38)
(DE91-008811; ANL/CP-71423; CONF-9002172-1) Avail: NTIS HC/MF A03

The role of synthesis conditions and oxygen treatment used for obtaining reproducible samples and reliable measurements leading to an understanding of the nature of high temperature superconductivity are discussed for La2CuO4+delta and Ba(1-x)K(x)BiO3. In both of these systems the oxygen defects are necessary to convert the semiconducting parent compounds into the doped conducting materials. For LaCuO4+delta, the superconductivity is due to excess oxygen which leads to phase separation and complex structural and transport properties. Oxygen deficiency is necessary for potassium incorporation into BaBiO3. The superconductivity in Ba(1-x)K(x)BiO3 is well described by the BCS theory in the weak to moderate coupling limit. The high Tc is caused by a large l angle omega r angle due to the strong interaction of electrons with high energy optical phonons. DOE

**N91-20968#** Pacific Northwest Lab., Richland, WA.
**DEFECT ENHANCEMENT OF LOCAL ELECTRIC FIELDS IN DIELECTRIC FILMS**
S. M. Risser and K. F. Ferris Feb. 1991 8 p Presented at the 22nd Annual Symposium on Optical Materials for High Power Lasers, Boulder, CO, 24-26 Oct. 1990
(Contract DE-AC06-76RL-01830)
(DE91-008829; PNL-SA-18588; CONF-9010146-3) Avail: NTIS HC/MF A02

Different film deposition techniques have been found to generate distinct grain morphologies and defect distributions, which can result in a wide distribution of local field intensities. We have developed a lattice element model of an inhomogeneous medium, which we use to self-consistently determine the local internal electric field and polarization. We use this method to show the

sensitivity of the polarization to defect shape. The results of this method predict the local field to have a large range of values within the film and have been used to identify regions where the local field is a maximum. DOE

**N91-20969#** Argonne National Lab., IL.
**PHASE EQUILIBRIA IN THE Bi-Sr-Ca-Cu-O SYSTEM NEAR THE Bi2Sr2Ca1Cu2(y) SUPERCONDUCTOR AT 865 C IN OXYGEN**
T. G. Holesinger, D. J. Miller, and L. S. Chumbley 1991 15 p Presented at the Annual Meeting and Exhibition of the Minerals, Metals and Materials Society, New Orleans, LA, 17-21 Feb. 1991
(Contracts W-31-109-eng-38; W-7405-eng-82)
(DE91-008831; ANL/CP-72495; CONF-910202-4) Avail: NTIS HC/MF A03

Phase relations in the Bi-Sr-Ca-Cu-O system near the Bi2Sr2Ca1Cu2O(y) (2212) superconductor composition have been studied at 865 C in oxygen by systematically varying concentration of one element at a time. The resultant phases were identified by energy dispersive spectrometry (EDS) in a scanning electron microscope (SEM) and x-ray analysis while superconducting properties were evaluated based on resistance and magnetometer measurements. Slight variations in the stoichiometry of the 2212 phase with starting compositions have been observed. Transition temperatures (Tc) were correlated with overall sample composition as well as the composition of the superconducting phase. DOE

**N91-20208*#** National Inst. of Standards and Technology, Gaithersburg, MD. Inst. for Materials Science and Engineering.
**HIGH T(SUB c) SUPERCONDUCTORS: ARE THEY MAGNETIC**
Robert D. Shull *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 1-5 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 20L

**N91-20215*#** Wentworth Inst., Boston, MA.
**CRYSTAL GROWING**
J. P. Neville *In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 35-36 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 20L

**N91-20223*#** Colorado Superconductor, Inc., Fort Collins.
**HIGH TEMPERATURE SUPERCONDUCTORS: A TECHNOLOGICAL REVOLUTION**
*In* NASA, Langley Research Center, National Educators' Workshop: Update 1988. Standard Experiments in Engineering Materials Science and Technology Jan. 1990 p 71-83 (For primary document see N91-20207 12-23)
Avail: NTIS HC/MF A05 CSCL 20L

# 77 THERMODYNAMICS AND STATISTICAL PHYSICS

Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics.

For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

**N91-20970#** Mainstream Engineering Corp., Rockledge, FL. Thermal Systems Div.
**THERMODYNAMIC PROPERTIES OF REFRIGERANT MIXTURES Final Report, 21 Jun. - 21 Dec. 1989**
Lawrence R. Grzyll and John J. Silvestri 31 Jan. 1990 157 p
(Contract F08635-89-C-0354)
(AD-A230520; AFESC/ESL-TR-89-60) Avail: NTIS HC/MF A08 CSCL 13/1

The objective of this project was to analyze the impact of refrigerant mixtures on refrigeration system capacity and components. A heat pump computer simulator was developed to predict the change in system capacity of two baseline air-conditioning systems as a function of refrigerant mixture concentration. Refrigerant mixtures made of refrigerants normally stocked on Air Force bases were considered. GRA

**N91-20971#** Institute for Defense Analyses, Alexandria, VA.
**SOME INFORMAL THOUGHTS ON RELATIVITY AND LIMITATIONS ON INTERSTELLAR TRAVEL Final Report, Jun. - Aug. 1990**
Reinald G. Finke Dec. 1990 28 p
(AD-A230575; AD-E501340; IDA-P-2361; IDA/HQ-90-35646)
Avail: NTIS HC/MF A03 CSCL 22/1

A summary is given of aspects of special relativity considered to be pertinent to engineering understanding of interstellar flight. In particular, the implications of the concept of proper velocity, the effective velocity for a passenger, are reviewed. Limitations on interstellar flight in terms of time, acceleration, energy, and power are evaluated. Certain potential avenues open to propulsion and energy-source technology to achieve acceptable interstellar travel within these limitations are cited. In particular, the capabilities of electron-beam propulsion and antimatter-annihilation energy production are examined. GRA

**N91-20972#** Texas Univ., Austin. Center for Statistical Mechanics and Complex Systems.
**TIME, DYNAMICS AND CHAOS**
I. Prigogine 1990 25 p Presented at the 26th Nobel Conference, St. Peter, MN, 2-3 Oct. 1990
(Contract DE-FG05-88ER-13897)
(DE91-008316; CONF-9010321-1) Avail: NTIS HC/MF A03

This report discusses the nature of time. The author attempts to resolve the conflict between the concept of time reversibility in classical and quantum mechanics with the macroscopic world's irreversibility of time. DOE

# 80 SOCIAL SCIENCES (GENERAL)

Includes educational matters.

No abstracts in this category.

# 81 ADMINISTRATION AND MANAGEMENT

Includes management planning and research.

**N91-20973#** Office of Management and Budget, Washington, DC.
**STATISTICAL PROGRAMS OF THE UNITED STATES GOVERNMENT, FISCAL YEAR 1991**
Dec. 1990 40 p
(PB91-110593) Avail: NTIS HC/MF A03 CSCL 05B

The funding available in the President's budget for statistical activities is discussed. The budget for FY 1991 requested a little over $2.1 billion to fund statistical work, including nearly $246 million for continued support of activities associated with the 1990 Decennial Census. Information on over 70 agencies in the U.S. Government that have budgets of $500,000 or more for statistical activities is provided. The report fulfills a responsibility of the Office of Management and Budget under the Paperwork Reduction Act to report annually to the Congress on the status and budget for each major statistical program. GRA

**N91-20974#** National Academy of Sciences - National Research Council, Washington, DC. Office of Japan Affairs.
**EXPANDING ACCESS TO PRECOMPETITIVE RESEARCH IN THE UNITED STATES AND JAPAN: BIOTECHNOLOGY AND OPTOELECTRONICS**

1990 50 p
(PB91-127514) Avail: NTIS HC/MF A03 CSCL 05A

In January 1990 the Office of Japan Affairs (OJA) of the National Research Council (NRC) and the Japan Society for the Promotion of Science (JSPS) jointly held the second of a series of meetings on the subject of symmetrical access to research and development (R and D) in Japan and the United States. Biotechnology and optoelectronics were selected as two important areas in which precompetitive research can theoretically benefit both countries and where the competitive circumstances are different. The meeting brought together experts in biotechnology, optoelectronics, and science policy from both countries to examine the current R and D structure in each country and to develop potential means for expanded access and cooperation. A synthesis of the major ideas garnered from the two-day meeting is presented. A preliminary survey conducted by OJA as well as insights gained by U.S. participants and NRC staff in preparing for the meeting and in reflecting on the discussions is also presented. GRA

**N91-20975#** National Academy of Sciences - National Research Council, Washington, DC. Office of Japan Affairs.
**SCIENCE, TECHNOLOGY, AND THE FUTURE OF THE US-JAPAN RELATIONSHIP**
1990 21 p
(PB91-127522) Avail: NTIS HC/MF A03 CSCL 05A

The U.S.-Japan relationship in science and technology is undergoing significant changes which present dilemmas for policymakers, business people, and researchers in both countries. The global context is changing particularly in the dynamic economies of East Asia and in Europe. However, at the core of the significant changes is Japan's emergence as a technological superpower. From the perspective of the United States, a major challenge is to develop mechanisms for acquiring technological know-how from Japan and to bring that knowledge to bear in increasing the competitiveness of manufacturing and service industries. Japan, on the other hand, faces challenges in developing basic research capabilities and mechanisms for transferring technology to the rest of the world. Developing effective responses to these challenges should be a top national priority. GRA

**N91-20976#** National Academy of Sciences - National Research Council, Washington, DC. Office of Japan Affairs.
**LEARNING THE R AND D SYSTEM: UNIVERSITY RESEARCH IN JAPAN AND THE UNITED STATES**
1989 27 p
(PB91-130443) Avail: NTIS HC/MF A03 CSCL 05A

The Office of Japan Affairs of the National Research Council is organizing a series of workshops on the differences and similarities in the working environment for research in Japan and the United States. Understanding these differences is essential to American scientists and engineers to improve access to Japan's research system, and to expand mutually beneficial collaboration between the two countries. The first workshop was on the culture of academic research, large university research laboratories, university-industry relations, and the experiences of foreign researchers in the United States and Japan. The major insights garnered from the two-day meeting are highlighted. GRA

**N91-20977#** National Academy of Sciences - National Research Council, Washington, DC. Office of Japan Affairs.
**LEARNING THE R AND D SYSTEM: INDUSTRIAL R AND D IN JAPAN AND THE US**
1990 49 p
(PB91-130427) Avail: NTIS HC/MF A03 CSCL 05A

The Office of Japan Affairs of the National Research Council organized a series of workshops on the differences and similarities in the working environment for research in Japan and the United States. Understanding these differences is essential in order to expand U.S. scientists' and engineers' access to Japan's research and development (R&D) system and to enhance mutually beneficial collaboration between the two countries. Major themes are highlighted from the third workshop in the series. GRA

**N91-20978#** Carnegie-Mellon Univ., Pittsburgh, PA. Robotics Inst.
**EXPLOITING LOCAL FLEXIBILITY DURING EXECUTION OF PRE-COMPUTED SCHEDULES**
Stephen F. Smith, Naiping Keng, and Karl Kempf Jun. 1990 16 p Prepared in cooperation with Intel Corp., Santa Clara, CA
(AD-A230114; CMU-RI-TR-90-13) Avail: NTIS HC/MF A03 CSCL 13/8

This paper addresses the problem of realizing the benefits of pre-computed schedules in the face of partially unpredictable execution environment. We focus specifically on the problem of manufacturing production scheduling, where advance planning is crucial to overall factory performance but is, at the same time, confounded by the unpredictability of factory operations. We present a scheduling framework where decision-making responsibility is shared between a global scheduler, responsible for establishing and maintaining execution constraints in accordance with overall performance objectives, and a local dispatcher, responsible for containing execution within globally imposed constraints and notifying the scheduler when containment is no longer possible. We identify the sources of local executional flexibility that can be expected in a pre-computed schedule, and describe an execution-time scheduler (the dispatcher) capable of exploiting this flexibility. GRA

**N91-20979#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
**A PERFORMANCE ANALYSIS OF THE USAF WORK INFORMATION MANAGEMENT SYSTEM M.S. Thesis**
Reno T. Lippold Sep. 1990 212 p
(AD-A229788; AFIT/GEM/LSM/90S-9) Avail: NTIS HC/MF A10 CSCL 05/2

Information was collected and analyzed which relates to system performance of the Work Information Management System (WIMS). Information on system performance analysis and tuning is consolidated by means of literature review and interviews of experts. A combination tutorial and questionnaire is developed to collect the data. Two new measurement techniques are developed. Data are collected and summarized on system performance knowledge and involvement in the field. Data are collected on system parameter settings and configuration, external factors related to system performance, and levels of system performance. The data are analyzed to provide a description of current performance conditions, to establish a baseline for future comparisons, and to determine or confirm relationships between performance related variables. Relationships between system performance and other variables are emphasized. Information is collected in fifteen areas of performance from forty-two bases. The research shows larger system memory and unfixed Sharer buffers are strongly related to better system performance. A list of suggested parameter settings is provided. Recommendations for future research in this area are presented. GRA

**N91-20980#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
**AN EMPIRICAL EVALUATION OF THREE KNOWLEDGE ACQUISITION TECHNIQUES FOR DEVELOPING A PROJECT MANAGEMENT RELATED EXPERT SYSTEM M.S. Thesis**
Todd T. Vikan Sep. 1990 102 p
(AD-A230472; AFIT/GSM/LSR/90S-32) Avail: NTIS HC/MF A06 CSCL 05/1

The acquisition of expert knowledge is recognized as one of the major hurdles facing the expert system programmer or knowledge engineer. Unfortunately, knowledge acquisition is seldom addressed in any detail in expert system literature, even though there exist a number of different techniques that a knowledge engineer can use to capture expert knowledge. The purpose of this study was to identify and evaluate the relative effectiveness of three knowledge acquisition techniques that may be used when developing expert systems for project management related tasks. The three techniques were interview, concept mapping, and interruption analysis. An experiment was conducted and quantitative measures of effectiveness were derived. GRA

**N91-20981#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
**AN ANALYSIS OF THE ADVANCED CRUISE MISSILE SYSTEM PROGRAM OFFICE ENGINEERING CHANGE PROPOSAL PROCESS M.S. Thesis**
Jeffery S. Robertson Sep. 1990 167 p
(AD-A230557; AFIT/GSM/ENC/90S-23) Avail: NTIS HC/MF A08 CSCL 15/5

This study investigated the engineering change proposal (ECP) process in the Advanced Cruise Missile System Program Office (SPO). Specifically, efforts were geared toward verifying a problem with the timeliness of the process and identifying the specific problems leading to untimeliness. Also, a survey questionnaire was analyzed to assist in the development of conclusions about the problems with the ECP process. The major conclusion was that the personnel in the Advanced Cruise Missile SPO were not taking advantage of the opportunity to review a preliminary copy of the ECP, called a Technical Change Package (TCP). By doing so, the SPO could have produced better quality ECPs which the approval authorities perhaps could have approved as written. However, because of content and documentation errors, the ECPs had to be deferred or approved with comments. These ECPs that were approved with comments required additional process steps which added significantly to the amount of time required for eventual approval. The recommendation was made for the SPO to educate the personnel about the importance of an adequate TCP review, encourage improvement through the adoption of an awards program, and take steps to educate those personnel in the SPO who need training. GRA

**N91-20982#** Defense Logistics Agency, Alexandria, VA. Operations Research and Economic Analysis Office.
**MULTIPLE FORECASTING TECHNIQUES Final Report**
Benedict C. Roberts Dec. 1990 56 p
(AD-A230600; DLA-91-P90053) Avail: NTIS HC/MF A04 CSCL 05/1

The Defense Logistics Agency (DLA) currently employs the Standard Automated Material Management System (SAMMS) under a mode which forecasts demand for all quarterly forecast demand (QFD) items through the use of a single forecasting technique. This approach for these QFD items has been shown in previous analysis to result in long term forecasting errors. The result of these errors in forecasts is that DLA has consistently maintained higher safety levels which has contributed to the presence of excess on-hand stocks. Consequently, the overall thrust of this analysis has been to enhance the forecasting methodology of SAMMS by exploring alternative forecasting techniques which would have the potential to enhance the accuracy of long term forecasts. The project has succeeded in the development of a multiple forecasting methodology which has the capability to select the most appropriate forecasting technique for each QFD item. GRA

**N91-20983#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
**AN ANALYSIS OF THE REQUIREMENTS CORRELATION MATRIX (RCM) AND BASELINE CORRELATION MATRIX (BCM) M.S. Thesis**
David K. Struck Sep. 1990 111 p
(AD-A230630; AFIT/GSM/LSY/90S-29) Avail: NTIS HC/MF A06 CSCL 05/1

This purpose of this thesis was to analyze the Requirements Correlation Matrix (RCM) and Baseline Correlation Matrix (BCM). The specific question addressed by the research was, what improvements can be made to better define and document the operational performance requirements during the acquisition of aeronautical weapon systems. Requirements personnel at using commands, the developing command, and the operational test agency were surveyed to determine who selects the parameters and values in RCMs and BCMs, and whether these personnel had differing interpretations of both requirements and specifications. The results indicated there was not a clear understanding of parameters and values as requirements or specifications by all requirements personnel, and a lack of sufficient acquisition education opportunities existed for requirements personnel at the using commands. The recommendations were that requirements personnel must understand the implications of the selection of parameters in RCMs/BCMs, more requirements oriented acquisition education for using command personnel is necessary to enhance the effectiveness of the RCM/BCM, and that a formal generai officer review of requirements should be conducted for major weapon systems to ensure that they are mission essential. GRA

**N91-20166#** Joint Publications Research Service, Arlington, VA.
**ISSUES IN SPACE POLICY, BUDGETING**
Vsevolod Sergeyevich Avduyevskiy and Leonid Vasilyevich Leskov *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 54-72 Transl. into ENGLISH from Novoye v Zhizni, Nauke, Tekhnike: Seriya Kosmonavtika, Astronomiya (Moscow, USSR), no. 4, Apr. 1990 p 3-49 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

**N91-20675*#** Mitre Corp., Bedford, MA.
**THE RANGE SCHEDULING AID**
Eliezer M. Halbfinger and Barry D. Smith *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 280-284 Sponsored in part by ESD, Hanscom AFB, MA (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 05A

**N91-20676*#** IBM Federal Systems Div., Colorado Springs, CO.
**REQUEST GENERATION 2 MISSION PLANNING AND SCHEDULING**
Darlene D. Greenhut *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 285-289 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 05A

**N91-20677*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**THE AMES-LOCKHEED ORBITER PROCESSING SCHEDULING SYSTEM**
Monte Zweben and Robert Gargan (Lockheed Missiles and Space Co., Palo Alto, CA.) *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 290-295 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 05A

**N91-20680*#** Lockheed Space Operations Co., Cocoa Beach, FL.
**KSC'S WORK FLOW ASSISTANT**
John Wilkinson and Earl Johnson *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 317-322 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 05A

**N91-20704*#** Georgia State Univ., Atlanta. Center for Human-Machine Systems Research.
**MODEL-BASED DISPLAYS FOR SATELLITE GROUND CONTROL**
Christine M. Mitchell *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 490-492 (For primary document see N91-20702 12-59)
(Grant NAG5-1044)
Avail: NTIS HC/MF A14 CSCL 05A

# 82 DOCUMENTATION AND INFORMATION SCIENCE

Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography.

For computer documentation see *61 Computer Programming and Software.*

**N91-20984#** Laboratoire National d'Essais (France).
**PROGRESS OF THE LABORATOIRE NATIONAL D'ESSAIS IN THE FIELD OF MATERIALS DATA BANK**
Jean-Pierre Caliste 1991 6 p
Avail: NTIS HC/MF A02

The state of the developments of numerical and factual materials data banks in order to take into account the scientific or technical point of view and the needs of the end user's needs is presented. These two public data banks are: COMAR (REFDATA) for the Certified Reference Materials (CRM), and SPAO for polymers. The notion of quality is essentially developed for each step of the constitution of the data bank: indexing, treatment of the data, and retrieval of information. Author

**N91-20985#** Ministere de l'Education Nationale, de la Jeunesse et des Sports, Paris (France). Direction de la Programmation et du Developpement.
**REVIEW OF MATERIALS DATA BANKS IN FRANCE**
Bernard Marx 1991 14 p
Avail: NTIS HC/MF A03

The French production of factual materials data reflects the diversity of materials science. In spite of the small number of realizations and some uncertainties concerning the trends of existing services, it is possible to note two main categories: numerical data are mainly produced by university laboratories but also by public research centers: the main interest in fundamental and physical property is their specific software treatment for correlation, simulation, forecasting, and modeling. These data banks are more frequently available by ASCII online mode or locally. Technological and commercial data are produced by public research centers, industrial technical centers, and industrial companies. Textural-numerical and directory are the most common types of data. The data include materials characteristics and mechanical properties. These data banks are often available by online videotex access model. Over the last years, materials data banks have developed in France, Europe, and foreign countries. It is the aim of CODATA FRANCE to establish a permanent link between work in progress and the needs of industry which develops its own internal services when useful public information services are not available. Coproduction centers must be developed to allow the external user to rapidly obtain a decisive quantity of data which are of interest. This coproduction must be organized on a national level, but also on an European and international level. French and international standards must be included in material data banks with frequent updatings. The validation of data is very important for both numerical and textural-numerical data. Updates should not be only additions, but they should include modification and better precision of the values. The development of user friendly gateways should be very useful. It is expected that this reciprocity of better knowledge of the Japanese and French characteristics of scientific and technical data bases should permit the definition of cooperation in the field of production, validation, and use of materials data banks. Author

**N91-20986#** Xerox Palo Alto Research Center, CA. Systems Sciences Lab.
**REBUILDING DATABASE CACHES DURING FAST CRASH RECOVERY**
Robert B. Hagmann Apr. 1990 14 p
(PB91-113050; CSL-90-2) Copyright Avail: NTIS HC/MF A03 CSCL 05B

Most database systems use a disk log for fast crash recovery. Changes to the standard logging and recovery algorithms are proposed to make them faster and able to recover various caches at little cost. One interesting cache is the buffer pool. For large configurations, the buffer pool (including old clean pages) is rebuilt from the log. During recovery, essentially all disk I/O is the sequential reading of the log. With enough main memory, no random reads or writes to the disk database occur during recovery. GRA

**N91-20987#** Environmental Protection Agency, Washington, DC. Office of Information Resources Management.
**ACCESS EPA. CLEARINGHOUSES AND HOTLINES: INFORMATION GUIDE**
Aug. 1990 47 p
(PB90-237082) Avail: NTIS HC/MF A03 CSCL 05B

U.S. Environmental Protection Agency (EPA) maintains a series of directories to improve access to environmental information services provided by EPA and other public sector organizations. The directories support the Agency's mission. Each directory provides contact information and a description of services. The directories are updated annually. Current directories in the series are: State Environmental Libraries; Major EPA Dockets; Libraries and Information Services; and Clearinghouses and Hotlines. GRA

**N91-20988*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**SUMMARY REPORT TO PHASE 1 RESPONDENTS INCLUDING FREQUENCY DISTRIBUTIONS**
Thomas E. Pinelli, John M. Kennedy, and Terry F. White (Indiana Univ., Bloomington.) Jan. 1991 48 p
(NASA-TM-102773; NAS 1.15:102773; Rept-5) Avail: NTIS HC/MF A03 CSCL 05B

Phase 1 of a four part study was undertaken to investigate the use of scientific and technical information (STI) by U.S. aerospace engineers and scientists. Specific attention was paid to institutional and sociometric variables and to the step-by-step process of information gathering used by the respondents. Data were collected by means of three self-administered mail-back questionnaires. The approximately 34,000 members of the American Institute of Aeronautics and Astronautics served as the study population. More than 65 percent of the randomly selected respondants returned the questionnaires in each of the three groups. Respondants relied more heavily on informal sources of information than formal sources and turned to librarians and other technical information specialists only when they did not obtain results via informal means or their own formal searches. The report includes frequency distributions for the questions. Author

**N91-20989#** Naval Postgraduate School, Monterey, CA.
**A NAVAL AVIATION MAINTENANCE ORGANIZATIONAL ACTIVITY STRATEGIC INFORMATION SYSTEM (OASIS) M.S. Thesis**
John H. Chase, Jr. Mar. 1990 133 p
(AD-A229905) Avail: NTIS HC/MF A07 CSCL 12/7

Organizational Maintenance Activities (OMAs) within the Naval Aviation Maintenance organization do not have an adequate information system (IS). This seriously degrades their ability to efficiently and effectively manage their aircraft, equipment, and personnel. Information systems to support both Naval Air Systems Command (NAVAIR) and the operational chain of command include Naval Aviation Depot Information System (NADIS), Naval Air Logistics Data Analysis (NALDA), and Naval Aviation Logistics Command Management Information System (NALCOMIS). The portion of NALCOMIS intended to support OMAs is not scheduled to be fully implemented until 1999. Decisions made at OMAs have an immediate impact on force readiness and mission capability. Moreover, the largest unfulfilled need for information systems in naval aviation community is at the OMAs. The history is examined of Information system in Aviation Maintenance, why OMAs lack adequate information systems is analyzed, and a solution is offered within the current technological capabilities of the aviation maintenance community. The potential improvement in operational readiness, avoidance of increased maintenance and personnel costs, improved decision making, and accuracy of information made

available to all levels of the Navy chain of command makes implementing an Organizational Activity Strategic Information System (OASIS) imperative. GRA

**N91-20990#** Air War Coll., Maxwell AFB, AL.
**DATA AND INFORMATION INTEGRITY IN A DISTRIBUTED ENVIRONMENT**
D. C. Abernethy, Jr. May 1990 50 p
(AD-A229949) Avail: NTIS HC/MF A03 CSCL 12/7

The 90's will be the era of information management in computer processing. Information management demands the integrity of data and information that we process and handle. As we move into this new age, we are losing the ability to ensure integrity in a distributed processing environment. This is due part to the proliferation of terminals, workstations and the advent of networking as we move from a centralized approach to data processing and data-basing. Integrity is more than a security issue. It encompasses accuracy, correctness, and validity of data. Database development, database management systems, networking of terminal and systems, and the distributed environment of software and information compound integrity concerns. Until we recognize that information is our most precious resource, we will ignore the importance of integrity concerns and their impact on the computer world. This paper will address these issues. Author (GRA)

**N91-20991#** Army Research Inst. for the Behavioral and Social Sciences, Alexandria, VA.
**TECHNIQUES TO AID DoD WRITERS IN DEVELOPING USER-ORIENTED DIRECTIVES Final Report, Jan. - May 1990**
Richard P. Kern, V. M. Holland, Joan Harman, and Sally Bell Sep. 1990 120 p
(AD-A229962; ARI-RP-90-33) Avail: NTIS HC/MF A06 CSCL 05/2

Findings are drawn from document design research to identify key features of effective work oriented documents and techniques writers can use to identify potential users and their diverse needs for information are presented. A technique is presented for structuring and monitoring organization of drafts to produce a document that effectively addresses the users' needs. Guidelines are presented for deciding when special formats should supplement or replace standard text. Key features are also presented of clear writing reflected in structuring of sentences and paragraphs and in choice of words. GRA

**N91-20992#** RAND Corp., Santa Monica, CA.
**RAND DATABASE HANDLING (DBH) SYSTEM USER GUIDE**
Walter V. Hobbs and Donald E. Lewis Oct. 1990 30 p
(AD-A230216; RAND/N-3104-AF) Avail: NTIS HC/MF A03 CSCL 12/5

The RAND Database Handling (DBH) System was developed to support the SAAFE database maintained by the PACAF Cryptologic Support Group. This consists of five separate computer programs, each of which the user executes individually. Each program accomplishes a specified task relative to the overall requirement of processing data and generating reports. First, raw data are sorted and duplicate entries and unnecessary lines are removed by the sort program. Then the resulting file is broken into several manageable pieces, each a UNIX file, by the split program. An identifying field is also attached to each data entry by the split program. Next the data file is examined by the fix program and corrections are made to the data for misspelled words and format errors, etc. Although most of the errors and inconsistencies can be corrected by the program, some conditions must be manually changed by editing the individuals data files. Once through the fix program, the data are ready for the analyst to use. The next program, called select, generates a smaller file of particular interest. The final program is named sdcalc. It is used to compute specified values and generate analytic reports. GRA

**N91-20993#** Knowledge Based Systems, Inc. College Station, TX.
**DESIGN KNOWLEDGE MANAGEMENT SYSTEM (DKMS) Final Report, Sep. 1989 - Aug. 1990**
Richard J. Mayer Dec. 1990 143 p
(Contract F41622-89-C-0018)
(AD-A230266; AFHRL-TP-90-81) Avail: NTIS HC/MF A07 CSCL 12/7

This document describes the design knowledge management system (DKMS), which provides a software environment for both the development and the delivery of intelligent assistants. These intelligent assistants can be used for computer-aided design (CAD), computer-aided engineering (CAE), and computer-aided manufacturing (CAM) applications in product design, engineering, manufacturing, and logistics planning. The DKMS can be thought of as an integrated concurrent engineering system whose environment includes facilities for: (1) design knowledge representation including shape-based associative retrieval and container objects; (2) intelligent user interface including form feature interfaces and generalized constructive solid geometry (GCSG) engineer, (3) engineering performance modeling functionally including constraint management and bond graph techniques; (4) data integration support; and (5) configuration management. This facility will enable the delivery of design advice on-line to the designer as new definitions are being created. Backing up this geometry engine, a container object management system will be produced that extends the proven composite object capabilities by integrating geometry concepting and manipulation primitives into the basic object definition and inheritance lattice operators. As an initial manufacturability, reliability, and maintainability capability, the baseline system will include a manufacturability checker, an associated generative process planning system, and an engineering performance model development environment. GRA

**N91-20994#** Logistics Management Inst., Bethesda, MD.
**STANDARDIZING SUBMISSIONS TO THE MAJOR AUTOMATED INFORMATION SYSTEM REVIEW COUNCIL Final Report**
Aug. 1990 37 p
(Contract MDA903-85-C-0139)
(AD-A230405; LMI-PL901R1) Avail: NTIS HC/MF A03 CSCL 15/5

This paper examines the procedures the Assist Secretary of Defense (ASD) for Production and Logistics (P&L) uses in preparing submissions to the Major Automated Information System Review Council (MAISRC) and identifies benefits, costs, and organizational interfaces as areas in which standardization may benefit P&L-sponsored submissions. Benefits as presented in MAISRC submissions tend to be understated, principally because systems are frequently justified on the basis of quantifiable, economic criteria. The many unquantifiable system benefits are more difficult to analyze and consequently are often understated. In preparing MAISRC submissions, P&L needs to ensure that the cost structure of the proposed information system is consistent with its capability. All capabilities should have corresponding cost categories. Analysts must identify those costs and tabulate them across the full system life cycle. P&L should encourage the use of parametric costing methods at an early stage to supplement analogy based procedures and to validate engineering estimates and vendor quotes. Particular emphasis should be placed on software life-cycle costing. P&L should take the following steps to expedite the MAISRC process: (1) Articulate system requirements precisely, and structure the proposed cost analysis to reflect those requirements. (2) Clearly document the program costs and benefits, and indicate how each was measured. (3) Communicate early and frequently with other organizations in the MAISRC process, such as PA&E and the Office of the Director, Operational Test and Evaluation. GRA

**N91-20995#** Stanford Univ., CA. Dept. of Psychology.
**ACQUIRING GENERALIZATIONS TO ORGANIZE HUMAN DATABASES Final Technical Report, 1 Sep. 1987 - 31 Aug. 1990**

Gordon H. Bower and John P. Clapper 30 Nov. 1990 18 p
(Grant AF-AFOSR-0282-87; AF Proj. 2313)
(AD-A230415; AFOSR-90-1175TR) Avail: NTIS HC/MF A03
CSCL 05/9

This report describes a three-year program of research on category learning in unsupervised environments, and the role of learned categories in the processing and retention of individual instances. A computational model of unsupervised category learning is described, and the model's implications for the evaluation, comparison, and memorization of instances are explored in several experiments. A new index of unsupervised learning, referred to as attribute listing, was introduced and show it was shown that such learning tends to optimize the encoding of instance features and their organization in memory. The empirical techniques developed in this project appear to hold considerable promise for further research on conceptual knowledge and its role in cognitive performance. GRA

**N91-20996#** Battelle Columbus Labs., OH.
**CORE OPERATIONS OF THE METALS AND CERAMICS INFORMATION CENTER (A DOD INFORMATION ANALYSIS CENTER) Final Report, 15 Jun. 1983 - 30 Aug. 1990**
30 Aug. 1990 65 p
(Contract DLA900-83-C-1744)
(AD-A229682) Avail: NTIS HC/MF A04 CSCL 05/2

Included is a Table of Contents; an Introduction; Goals and Objectives; an Activity Summary; Acquisition and Input of Source Information; Acquisition of Information; Foreign Technology; DROLS Input; On-line Usage of the MCIC Database, and Concerns and Problems-Information Operations; Technical and Bibliographic Inquiry Services; Technical Publications; Current Awareness; a Contract Status Report; Special Tasks and Studies; and a listing of professional staff. GRA

**N91-20997#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**AIR FORCE INFORMATION MANAGEMENT (IM): A 1990 SNAPSHOT AND 1995 FUTURE LOOK AT AIR FORCE IM NEEDS AND PREFERRED EDUCATION/TRAINING APPROACHES M.S. Thesis**
Richard T. McGhee Dec. 1990 192 p
(AD-A229695; AFIT/GIR/LSM/90D-6) Avail: NTIS HC/MF A09
CSCL 05/1

This research investigated 37 training topics which were of interest to Air Force (AF) information managers, Air Force Specialty Code 70XX. The topics were grouped into the following seven information resource related clusters: (1) computer operating systems, (2) data communications, (3) Air Force Standard Systems (PDOS, RAMS, and PCIII), (4) information resource management concepts, (5) AF/IM career field issues, (6) computer hardware, and finally, (7) computer software. Twenty-four graduates of the AF Institute of Technology's (AFIT) Information Resource Management program were asked to provide their perceptions of AF information managers (IMs) current (1990) and needed (1995) knowledge/skill levels on each topic. Telephone interviews with the respondents indicated that, relative to the 37 topics discussed, the graduates perceived a significant difference between current and needed knowledge/skill levels in practically all topic areas. The respondents also provided recommendations on effective and practical training methods/approaches for closing knowledge/skill level gaps. Finally, the graduates provided feedback relative to the effectiveness of the IRM program. GRA

**N91-20998#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
**AN ASSESSMENT OF THE PROBLEMS SURROUNDING THE DATA ACQUISITION PROCESS, AND POSSIBLE IMPROVEMENTS M.S. Thesis**
Daniel C. Brink Sep. 1990 119 p
(AD-A229787; AFIT/GSM/LSY/90S-3) Avail: NTIS HC/MF A06
CSCL 05/2

The data management and data acquisition area of the overall acquisition process was studied. The investigation looked at seven studies, an Auditor General's Report, and a survey of data managers in Air Force Logistics Command and Aeronautical Systems Division of Air Force Systems Command. The purpose was to determine what problems with data management and data acquisition are universal across units, division, and commands. After identifying definite problem areas, the study probed the information to find what actions should be taken to improve the data acquisition process. The problems identified included a lack of personnel training, poor definition of data requirements, and a proliferation of data by the government. The study showed that data is a significant cost driver in the acquisition of systems and program managers are not aware of the extent of those costs. The data manager survey was examined to determine if AFLC and ASD data managers agreed as to the problems and possible solutions. Problems that permeate the acquisition process were found, thus enabling future policy decisions to address these problems. GRA

**N91-20999#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
**APPLICATION OF A MICRO COMPUTER-BASED MANAGEMENT INFORMATION SYSTEM TO IMPROVE THE USAF SERVICE REPORTING PROCESS M.S. Thesis**
Mark H. Mol Sep. 1990 148 p
(AD-A230552; AFIT/GSM/LSY/90S-21) Avail: NTIS HC/MF
A07 CSCL 12/5

This study conducted research into the development, implementation and evaluation of a personal computer based Service Reporting (SR) Management Information System (MIS). MIS experts and System Program Office (SPO) acquisition managers; and software prototyping with an Aeronautical Systems Division (ASD) SPO. The Service Reporting Management Information System (SRMIS) was implemented and evaluated in the Air Force One (AF-1) Replacement Aircraft SPO during a five month trial period. GRA

**N91-21000#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**SQL/NF TRANSLATOR FOR THE TRITON NESTED RELATIONAL DATABASE SYSTEM M.S. Thesis**
Craig W. Schnepf Dec. 1990 121 p
(AD-A230602; AFIT/GCE/ENG/90D-05) Avail: NTIS HC/MF
A06 CSCL 12/5

The problem addressed in this thesis concerns the design and implementation of a high level data base query language translator based on the nested relational data model. The objective of the model is to increase the performance of the relational model by modeling real-world objects in the problem domain into nested relations. The translator is designed within the EXODUS extensible architectural framework for building application-specific database systems. The SQL/NF query language used for the nested relational model is an extension of the popular relational model query language SQL. The query language is translated into a nested relational algebra (Colby algebra) in the form of a query tree structure. A large amount of theory exists for the nested relational model, however, very little information on the implementation of a high level query language for the model is available. This thesis effort provided the front end to a proto-type nested relational data base management system (Triton) using the EXODUS tool kit. In Triton, EXODUS is used to implement the first stages of the data base management system. These stages include the parser and the catalog manager. Since the EXODUS tool kit does not provide a parser development tool, we choose to use the popular UNIX tools 'LEX' and 'YACC' to parse the SQL/NF query statements and execute the C programs necessary for creating and maintaining a data dictionary, generating a SQL/NF query tree, and translating the SQL/NF query tree into a Colby algebra query tree. The Colby algebra tree is available for the next stage of the EXODUS architecture, the query optimizer. GRA

**N91-21001#** Logistics Management Inst., Bethesda, MD.
**THE COST OF INFORMATION SYSTEMS MODERNIZATION: A COMPARISON OF OPTIONS FOR LIFE-CYCLE PROJECT MANAGEMENT SYSTEMS**
Robert A. Hutchinson and Robert L. Crosslin Aug. 1990 73 p (Contract MDA903-90-C-0006)
(AD-A230675; LMI-CE002R1) Avail: NTIS HC/MF A04 CSCL 05/1

The U.S. Army Corps of Engineers (USACE) has undertaken a systems modernization program that will govern its information management for the next decade. One of the major systems being developed under this plan is the Life-Cycle Project Management (LCPM) system. It was found that the current LCPM prototypes not only differ significantly in design and configuration but also in the functions they perform and their flexibility for further modification and enhancement. The costs associated with the options for Corps-wide implementation of LCPM at multiple sites vary widely (ranging from $12 million for a centralized system to $49 million for a totally decentralized system). Under current plans, a relatively expensive decentralized system will likely be implemented. Implementation options are identified that can meet LCPM needs at significantly lower cost. It is also recommended that USACE minimize the number of prototypes to be continued, recommend selection of an LCPM system that is built around existing commercial project management software, and centralized systems management and maintenance. GRA

**N91-21002#** Institut Franco-Allemand de Recherches, Saint-Louis (France).
**CATALOG OF PUBLICATIONS PUBLISHED AT THE FRENCH-GERMAN INSTITUTE OF RESEARCH [CATALOGUE DES PUBLICATIONS EDITEES A L'ISL]**
1989 30 p Partly in ENGLISH; FRENCH; and GERMAN
(ETN-91-98910) Avail: NTIS HC/MF A03

A list of the publications by the ISL during 1989 is presented. The number of pages in each publication is listed as well as the title of the publication and key words in both French and German. When French or German translations of the entire text are available, the possibility is listed. ESA

**N91-21003#** Royal Signals and Radar Establishment, Malvern (England).
**TRANSLATING DATA FLOW DIAGRAMS INTO Z (AND VICE VERSA)**
G. P. Randell Oct. 1990 27 p
(RSRE-90019; BR115966; ETN-91-98999) Copyright Avail: NTIS HC/MF A03

The results of work into the integration of structured and formal methods, in particular, data flow diagrams and Z, are described. Data flow diagrams are given a formal, mathematical basis by defining rules to translate these diagrams into Z. Rules are also given for generating a data flow diagram from a Z specification, and for checking the compatibility of a data flow diagram and a Z specification. The SSADM (Structured Systems Analysis and Design Methods) conventions are used for data flow diagrams, although the work is more widely applicable with some minor modifications. ESA

**N91-21004** National Physical Lab., Teddington (England). Div. of Radiation Science.
**LIST OF ALL RSA (EXTERNAL) REPORTS ISSUED BY THE DIVISION OF RADIATION SCIENCE AND ACOUSTICS TO DATE**
Nov. 1990 4 p
(NPL-RSA(EXT)-1; ISSN-0955-9655; ETN-91-99028) Copyright Avail: National Physical Lab., Teddington, Middlesex, TW11 0LW, England

A list of all RSA (Division of Radiation Science and Acoustics) (external) reports to date with the names of their authors and dates of issue, is given. These include the evaluation of small area membrane hydrophones; survey on tritium and radon standards; the effect of surface materials on radioactive surface contamination measurements; environment radioactivity measurement intercomparison exercise; use of Linac for X-ray dosimetry; conversion of absorbed dose from graphite into water; the role of NPL in medical metrology; noise levels from VSTOL (Vertical Takeoff and Landing) aircraft measured at ground level and at 1.2 meters above the ground; speech databases for UK speech technology research: a survey of resources and future needs; derivation of radiation beam non uniformity corrections for the calibration of large volume ionization chambers; NPL absorbed dose graphite calorimeter correction for the effect of the gaps around the core in high energy photon radiation; an evaluation of a model for predicting temperature rise in tissue due to the absorption of ultrasound. ESA

**N91-21005#** Department of Energy, Washington, DC. Energy Information Administration.
**RESERVES INFORMATION GATHERING SYSTEM USER'S GUIDE**
17 Jan. 1991 66 p
(DE91-008037; DOE/EIA-M-042(90)) Avail: NTIS HC/MF A04

The Reserves Information Gathering System, hereafter referred to as RIGS, is an advanced electronic data entry product developed by the Department of Energy as a more efficient, accurate, and timely alternative for submission of Form EIA-23, Annual Survey of Domestic Oil and Gas Reserves, to the Energy Information Administration (EIA). Use of RIGS software is voluntary. The IBM compatible computer was chosen as the hardware component of RIGS because of its wide availability. Error messages are designed to prevent inadvertent entries, and help screens and messages answer most on-line questions that may arise. Company and state/state subdivision totals can be automatically generated, and print functions are available to produce hard copy of an individual group and/or total fields reported. DOE

## 83 ECONOMICS AND COST ANALYSIS

Includes cost effectiveness studies.

No abstracts in this category.

## 84 LAW, POLITICAL SCIENCE AND SPACE POLICY

Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

**N91-21006#** Committee on Appropriations (U.S. Senate).
**DEPARTMENTS OF VETERANS AFFAIRS AND HOUSING AND URBAN DEVELOPMENT, AND INDEPENDENT AGENCIES APPROPRIATIONS FOR FISCAL YEAR 1991, PART 2**
Washington GPO 1991 557 p Hearings on H.R. 5158 before the Committee on Appropriations, 101st Congress, 2d Session, 29 Mar., 3-4 May, and 8 May 1990
(S-Hrg-101-1099-Pt-2; GPO-26-232) Avail: Subcommittee of the Committee on Appropriations, Senate, Washington, DC 20510 HC free; also available SOD HC 16.00 as 552-070-09823-2

Hearings before a subcommittee of the Senate Committee on Appropriations are presented along with budget estimates for the fiscal year 1991 for the Departments of Veterans Affairs and Housing and Urban Development, and Independent Agencies, one of which is the National Aeronautics and Space Administration. All written testimony and submittals for the record are included. For individual titles, see N91-21007 through N91-21007.

**N91-21007#** Committee on Appropriations (U.S. Senate).
**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION**
*In its* Departments of Veterans Affairs and Housing and Urban Development, and Independent Agencies Appropriations for Fiscal

Year 1991, Part 2 1991 p 239-548 (For primary document see N91-21006 12-84)
Avail: Subcommittee of the Committee on Appropriations, Senate, Washington, DC 20510 HC free; also available SOD HC 16.00 as 552-070-09823-2

Following opening statements of members of the Subcommittee of the Senate Committee on Appropriations, the National Aeronautics and Space Administration presents its fiscal year 1991 budget. Comments on the various budgeted items begin with a summary of previously approved programs. Also noted are proposed new initiatives, which amount to 2 percent of the total budget request. Programs discussed include expendable launch vehicles, the Hubble Space Telescope, the Space Station Freedom, planetary exploration, research and development, university programs, communications, observations of Earth, the moon-Mars initiative, and space shuttles, a series of written questions and answers follow the oral presentation. J.P.S.

**N91-21008#** Congress of the United States, Washington, DC.
**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION AUTHORIZATION ACT, FISCAL YEAR 1991**
Washington GPO 16 Nov. 1990 21 p S. 2287 enacted into law by the 101st Congress, 2d Session, 16 Nov. 1990
(Pub-Law-101-611) Avail: Document Room, Senate, Washington, DC 20510 HC free; also available SOD HC $1.00 as 869-010-00371-4

Text is presented of the public law authorizing appropriations to the National Aeronautics and Space Administration for research and development; space flight, control, and data communications; construction of facilities; research and program management; and for other purposes. Author

**N91-20170#** Joint Publications Research Service, Arlington, VA.
**US RELUCTANCE ON SPACE COOPERATION CRITICIZED Abstract Only**
A. Yakimenko *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 101 Transl. into ENGLISH from Krasnaya Zvezda (Moscow, USSR), 2 Nov. 1990 p 3 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

**N91-20668*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**ISSUES ASSOCIATED WITH ESTABLISHING CONTROL ZONES FOR INTERNATIONAL SPACE OPERATIONS**
Blair A. Nader and Kumar Krishen *In its* Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 207-225 (For primary document see N91-20641 12-59)
Avail: NTIS HC/MF A21 CSCL 05D

# 85 URBAN TECHNOLOGY AND TRANSPORTATION

Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.

For related information see also *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

**N91-21009#** Carnegie-Mellon Univ., Pittsburgh, PA. Rail Systems Center.
**COMMERCIALIZATION OF MAGLEV TECHNOLOGY Final Report, Dec. 1987 - 1 May 1989**
Richard A. Uher Aug. 1990 85 p
(Contract DOT-UMTA-PA-06-0111)
(PB91-121087; UMTA-PA-06-0111-90-1) Avail: NTIS HC/MF A05 CSCL 13F

In recognizing the need for United States MAGLEV technology for high speed regional MAGLEV systems, the focus of the study was designed to use foreign technology as developed in either Japan or Germany and Americanize this technology so that it could be manufactured and subsequently improved in the United States. A Pittsburgh regional MAGLEV project was put together which had three objectives: (1) a Pittsburgh region based MAGLEV industry; (2) a private/public partnership to build and operate a regional MAGLEV system; and (3) integration of the stops on the regional MAGLEV system into nodes of economic activity. GRA

**N91-20165#** Joint Publications Research Service, Arlington, VA.
**CONVERSION OF THE TECHNOLOGY FOR THE PRODUCTION OF THE ENERGIYA-BURAN SYSTEM IN THE NATIONAL ECONOMY Abstract Only**
V. I. Grigoryev *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 53 Transl. into ENGLISH from Vestnik Mashinostroyeniya (Moscow, USSR), no. 5, May 1990 p 47-49 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

**N91-20167#** Joint Publications Research Service, Arlington, VA.
**SPACE PROGRAMS IN PROGRAM 2005 ADVOCATED**
I. Yudin *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 78-81 Transl. into ENGLISH from Pod Znamenem Leninizma (Kiev, USSR), no. 5, Mar. 1990 p 77-81 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

**N91-20168#** Joint Publications Research Service, Arlington, VA.
**SEMENOV DISCUSSES BENEFITS FROM MIR PROGRAM, SHUTTLE VERSUS ELVS, CONVERSION**
N. Mikhaylov and G. Nikolayenko *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 82-85 Transl. into ENGLISH from Pravda Ukrainy (Kiev, USSR), 12 Apr. 1990 p 4 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

# 88 SPACE SCIENCES (GENERAL)

No abstracts in this category.

# 89 ASTRONOMY

Includes radio, gamma-ray, and infrared astronomy, and astrometry.

**N91-21010#** Brookhaven National Lab., Upton, NY.
**IMAGING PERFORMANCE AND TESTS OF SOFT X RAY TELESCOPES**
E. Spiller, R. McCorkle, J. Wilczynski, L. Golub, G. Nystrom, and P. Takacz Aug. 1990 13 p Presented at the 34th SPIE Annual International Technical Symposium on Optical and Optoelectronic Applied Science and Engineering, San Diego, CA, 8-13 Jul., 1990
(Contract DE-AC02-76CH-00016)
(DE91-007557; BNL-45580; CONF-900756-58) Avail: NTIS HC/MF A03

Photos obtained during 5 min. of observation time from the flight of our 10 in. normal incidence soft x ray (lambda = 63.5A) telescope on September 11, 1989 are analyzed and the data are compared to the results expected from tests of the mirror surfaces. These tests cover a range of spatial periods from 25 cm to 1A. The photos demonstrate a reduction in the scattering of the multilayer mirror compared to a single surface for scattering angles above 1 arcmin, corresponding to surface irregularities with spatial periods below 10 micron. The results are used to predict the possible performance of future flights. Sounding rocket observations might be able to reach a resolution around 0.1 arcsec.

Higher resolutions will require flights of longer durations and improvements in mirror testing for the largest spatial periods.
DOE

**N91-21011*#** Wisconsin Univ., Madison. Dept. of Physics.
**X RAY ABSORPTION BY DARK NEBULAE (HEAO-2 GUEST INVESTIGATOR PROGRAM) Final Report**
W. T. Sanders 19 Apr. 1991 20 p
(Grant NAG8-401)
(NASA-CR-188076; NAS 1.26:188076) Avail: NTIS HC/MF A03 CSCL 03A

A study is described of data obtained from the Imaging Proportional Counter (IPC) x ray detector aboard the HEAO-2 satellite (Einstein Observatory). The research project involved a search for absorption of diffuse low energy x ray background emission by galactic dark nebulae. The commonly accepted picture that the bulk of the C band emission originates locally, closer that a few hundred parsec, and the bulk of the M band emission originates farther away than a few hundred parsec, was tested. The idea was to look for evidence of absorption of the diffuse background radiation by nearby interstellar clouds. Author

# 90 ASTROPHYSICS

Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.
For related information see also *75 Plasma Physics*.

**N91-21012*#** Southwest Research Inst., San Antonio, TX.
**WORKSHOP ON OBSERVATIONS OF RECENT COMETS (1990) Final Report**
Walter F. Huebner, ed., Peter A. Wehinger, ed., Jurgen Rahe, ed. (National Aeronautics and Space Administration, Washington, DC.), and Ichishiro Konno, ed. 1990 184 p Workshop held in Albuquerque, NM, 15-16 Jun. 1990
(Grant NAGw-1130; SwRI Proj. 15-1886)
(NASA-CR-187635; NAS 1.26:187635) Avail: NTIS HC/MF A09 CSCL 03B

Potential interpretations are presented for observations of four comets: Brorsen-Metcalf (1989o), Okazaki-Levy-Rudenko (1989r), Aarseth-Brewington (1989a1), and Austin (1989o1). The relationship of minor species with each other and possible parents as well as with dust are being pursued in a number of investigations. Of particular interest are the abundance ratios of CH4 to CO and NH3 to N2. The need for closer collaboration betwen observing teams and modelers is examined. The need for dust size distribution as a function of cometocentric distance to be analyzed in closer collaboration between observers and modelers is discussed. For individual titles, see N91-21013 through N91-21047.

**N91-21013*#** Southwest Research Inst., San Antonio, TX.
**RESULTS FROM THE COMET GIACOBINI-ZINNER AND HALLEY CAMPAIGNS**
Walter F. Huebner *In its* Workshop on Observations of Recent Comets (1990) 1990 p 1-7 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

The spacecraft flybys of Comets Giacobini-Zinner and Halley were highly successful. Many untested theories were confirmed and additional clues provided to decide between competing models, but without leading to a clear preference. New questions were also raised. Based on the improved knowledge, research efforts will now be much better focused than was possible before the encounters. Moreover, interpretation of the Earth-based (ground-based, airborne, rocket-borne, and Earth satellite) observations should be improved. The goals of the workshop are defined in terms of the results from spacecraft measurements and Earth-based observations of Comets Giacobini-Zinner and Halley. A summary is presented of the new knowledge about the nucleus, the coma gas and dust, and the plasma. It is realized that extreme caution must be used when generalizing results from the Comet Giacobini-Zinner and Halley investigations to comets universally. The many surprises of the successful missions, the dangers inherent in generalizations to other comets, and the many still open and new questions are the reasons for the need of further spacecraft investigations. However, an unquestionably successful start was made in expanding the knowledge about the physics and chemistry of comets and all the related implications, and the question about the similarities of and differences between comets can now be explored further. Author

**N91-21014*#** Lowell Observatory, Flagstaff, AZ.
**PHOTOMETRIC NARROWBAND CCD IMAGING OF COMETS P/BRORSEN-METCALF AND AUSTIN (1989c1)**
David G. Schleicher, David J. Osip, Robert L. Millis, Andrea Thompson, and Linda M. Sauter (Massachusetts Inst. of Tech., Cambridge.) *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 8-12 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

Simultaneous wide-field CCD images and conventional aperture photometry were obtained of Comets P/Brorsen/Metcalf (1989o) and Austin (1989c1). These data allow direct testing of absolute calibration of the CCD images and the ability to generate full-come, continuum-subtracted emission band images. Preliminary photometric calibration for a portion of the Brorsen-Metcalf observations yields reduced emission band and continuum fluxes which agree to within about 10 percent with those from the photoelectric observations. Conventional photometry of Comet Austin shows unusual variations among the production rates of the different species as a function of heliocentric distance.
Author

**N91-21015*#** Tokyo Astronomical Observatory, Mitaka (Japan).
**OPTICAL AND NEAR-IR IMAGING OBSERVATIONS OF COMET AUSTIN 1989c1**
J. Watanabe, N. Hiromoto, H. Takami, Te. Aoki, T. Nakamura, K. Takagishi, I. Hatsukade, S. Isobe, G. Sasaki, and H. Sugai (Tokyo Univ., Japan ) et al *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 13-17 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

Near-nucleus imaging observations of comet Austin (1989c1) were carried out by the Japanese CCD imaging team. Six telescopes were used to monitor the time variation of the near-nucleus images in C2, CN, H2O, and Na continuum in the optical region, and in J, H, and K bands in the near-IR region. A featureless, round shape of the comet was revealed in all images. Although some of the jet features are recognized by using an image enhancement technique, the azimuthal difference of the intensity distribution is about 10 percent. The images in the H2O band show complex ion structures near the nucleus. Author

**N91-21016*#** Arizona Univ., Tucson. Lunar and Planetary Lab.
**A COMPOSITION COMPARISON BETWEEN COMETS P/HALLEY AND P/BRORSEN-METCALF**
Michael A. DiSanti and Uwe Fink *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 18-21 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

The appearance of comet Brorsen-Metcalf in 1989 following only a few years on the heels of comet Halley in 1986 gave an unusual opportunity to compare two comets of similar orbital elements but potentially different physical and chemical characteristics. Photometric spectral data were acquired for Brorsen-Metcalf on two dates: 13 July 1989 and 2 August 1989. The observations were performed with the 154 cm Catalina Telescope of the University of Arizona Observatories. The spectrum for 13 July 1989 is compared to a Halley spectrum. The general appearance of the spectra is very similar, both comets showing emission due to C2, NH2, OI(D-1), and CN. Neither displays any emission features that are exclusive to only one of the two. Since water is now reasonably well established as the major driving force in the activity of a comet, the H2O production rate for comet Brorsen-Metcalf was calculated. The relative ratios between the

production rates of the various species obtained from the data are presented. Results are summarized in tabular form. All species are compared to the H2O production rate of the two comets. The results indicate that C2 originates from an extended source of dust particles or small polymers in addition to parent molecules. The lower production rates of C2 and CN in Brorsen-Metcalf correlate well with both the lower dust production and their smaller increase as the comet approaches the sun. Even without a mode, the spectroscopic observations of Brorsen-Metcalf allowed significant compositional conclusions to be drawn. The NH2 abundance is lower by about a factor of three which appears to be independent of heliocentric distance. Both C2 and CN are less abundant in Brorsen-Metcalf than in Halley and do not seem to participate as much in the strong increase as the comet approaches the sun. The lower H2O production rate implies that the active surface area of the comet Brorsen-Metcalf is much smaller, or equivalently the comet as a whole is much smaller. The substantially lower continuum level for Brorsen-Metcalf cannot readily be explained by smaller or larger active surface area, and must be intrinsic to the comet's embedded dust-to-ice ratio, or to an overall smaller-sized dust grain population. B.G.

**N91-21017*#** McDonald Observatory, Austin, TX.
**OBSERVATIONS OF CH IN COMETS P/BRORSEN-METCALF AND P/HALLEY**
Anita L. Cochran and William D. Cochran *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 22-27 (For primary document see N91-21012 12-90)
(Grants NAGw-1477; NSF AST-89-12869)
Avail: NTIS HC/MF A09 CSCL 03B

A common feature in the visual spectra of comets is the A squared delta - chi squared pi transition of CH at 4314 A (delta v = 0). This feature is very weak and is easily lost in the continuum or noise. However, the oscillator strength is very small, so even a weak feature indicates a large amount of CH. Understanding the parent of the CH in the comae of comets is very important for understanding the chemistry of comets and, thus, the early solar nebula. Potential parents for the CH are CH4 or more complex hydrocarbons, including polyoxy methanes (POMs). The ratio of CH4 to H2O is indicative of possible sites of formation of the comets. Past observations of comets have shown that the CH is present in the coma. However, because of the intrinsic weakness of the feature and the ease of photodissociating CH, the distribution of the CH in the coma has only been traced in the inner coma, where the fall-off is still 1/p, where p is the impact parameter. The first data sets tracing the distribution of CH to large distances from the nucleus in two comets is presented. Some preliminary models are presented pertaining to the parent of the CH. Author

**N91-21018*#** Arizona State Univ., Tempe. Dept. of Physics and Astronomy.
**AMMONIA AND NITROGEN ABUNDANCES IN COMETS**
Susan Wyckoff *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 28-33 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

Comets consist of pristine material preserved from an earlier galactic epoch. Determination of the molecular, elemental, and isotopic abundances in the dust and volatile components of comet nuclei produce vital clues to the chemical evolution of both interstellar and solar nebula matter. Here the abundances of nitrogen-containing molecules in comets are considered. The molecular abundances of NH3 in four comets are summarized (Tegler 1990, Wyckoff, Tegler, and Engel, 1990). From an inventory of nitrogen-containing compounds (Wyckoff, Engel, and Tegler 1990, Wyckoff, Engel, Womack, Ferro, Tegler and Peterson, 1990), an estimate of the elemental N abundance is also presented.
Author

**N91-21019*#** Arizona State Univ., Tempe. Dept. of Physics and Astronomy.
**UNIDENTIFIED IONS IN COMETS**
Lisa Engel *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 34-39 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

Optical spectra were taken of comets Halley, West, and Brorsen-Metcalf in the wavelength region 3200 to 6400 A. These spectra were offset approximately 10(exp -5) to 10(exp -6) km tailward from the nucleus so that the features detected were all ions with the exception of a very small residual C2 emission at 5165 A. The full labeled tail spectrum of comet Halley is given. While most of the features detected are attributable to CO(+), H2O(+), CO2(+), CH(+), and OH(+), there are three moderately strong bands in the spectra of comets Halley and Brorsen-Metcalf which remain unidentified. These features were not detected in comet West. All three spectra in the 4800 to 5400 A region are presented, Brorsen-Metcalf is the gassiest of the three. The central wavelengths of the unidentified features are 4930, 5300, and 6000 A. In an effort to identify the ions responsible for these features as well as to confirm previous identifications, laboratory spectra of ions were compared with the comet spectra. H2O(+) and CO(+) are known to have extensive emission in the 4800 to 6200 A region. Therefore, the possibility that these unidentified features are due to H2O(+) and CO(+) was investigated. A search for the following bands was conducted: H2O(+) (11-0), H2O(+) (12-0), H2O(+) (13-1), CO(+) (1-1), and CO(+) (0-0). CO(+) (1-1) and CO(+) (0-0) were previously identified and are present in all the spectra examined. The H2O(+) (11-0) band was identified. Comparison of the H2O(+) (11-0) synthetic spectrum with comet Brorsen-Metcalf data is presented. The relative fluxes of the blended H2O(+) lines in the synthetic spectrum match those of the cometary data. After eliminating H2O(+) and CO(+) as significant contributors to the stronger unidentified features, spectra of ions which are not yet identified in the optical region of comets were compared to the data. These ions are NH(+), CS(+), and C2(+). None of these ions appears to be a significant contributor to the optical spectra of these three comets. In conclusion, H2O(+) (11-0) was unabiguously identified in cometary optical spectra. No other molecular ion for which there are laboratory spectra can explain the unidentified features found in the ion tails of comets Halley and Brorsen-Metcalf. Author

**N91-21020*#** Chicago Univ., IL.
**SIMULTANEOUS IMAGING OF OPTICAL CN LINES AND RADIO HCN LINES IN COMET AUSTIN**
Patrick Palmer, Mike F. AHearn, Imke dePater, James J. Klavetter, David Mehringer, F. Peter Schloerb, Lewis E. Snyder, and D. Wilner (California Univ., Berkeley.) *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 40-44 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

The parent molecule of cometary CN has been the subject of speculation for a long time. When HCN was detected at 3.4 mm in Comet Kohoutek, the problem seemed to be resolved, but much more detailed work on Comet Halley raised the quantitative question of whether HCN could be the only parent. Therefore, comparative CN/HCN studies are vital for understanding the origin of cometary CN. The striking observation of CN jets in Comet Halley raised another very interesting question about the origin of CN. Traditional theory permits only dust features to remain well defined far from the nucleus. The CN jets were interpreted as arising from submicron sized dust particles, perhaps CHON particles. An estimated 10 to 50 percent of the CN in the comet was in the jets in the Halley observations. Several hypotheses can be made: (1) some of the CN originates from the dust and has nothing to do with HCN; or, (2) at least some of the HCN is also produced from the dust in the coma rather than directly from the nucleus. (In the second hypothesis, whether CHN is or is not the parent of the CN associated with the dust would need to be established.) The extended scalelengths found for CO by Eberhardt et. al. (1987) and for H2CO by Snyder et. al. (1989) also support ideas like hypothesis (2). A third hypothesis should be mentioned; contrary to the usual theory, the gas flow does not become isotropic (Combi 1987). For all of the reasons mentioned, it is essential to make a

detailed comparison of the spatial distributions of CN and HCN. Furthermore, because of the variability of cometary emissions, it is necessary to make measurements simultaneously. Author

**N91-21021*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**FABRY-PEROT OBSERVATIONS OF COMET AUSTIN**
David Schultz, F. Scherb, F. L. Roesler, G. Li, J. Harlander, T. P. P. Roberts, D. VandenBerk, S. Nossal, M. Coakley, and Ronald J. Oliversen (National Solar Observatory, Tucson, AZ.) *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 45-49 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

Preliminary results of a program to observe Comet Austin (1990c1) from 16 April to 4 May and from 11 May to 27 May 1990 using the West Auxiliary of the McMath Solar Telescope on Kitt Peak, Arizona were presetned. The observations were made with a 15 cm duel-etalon Fabry-Perot scanning and imaging spectrometer with two modes of operation: a high resolution mode with a velocity resolution of 1.2 km/s and a medium resolution mode with a velocity resolution 10 km/s. Scanning data was obtained with an RCA C31034A photomultiplier tube and imaging data was obtained with a Photometrics LN2 cooled CCD camera with a 516 by 516 Ford chip. The results include: (1) information on the coma outflow velocity from high resolution spectral profiles of (OI)6300 and NH2 emissions, (2) gaseous water production rates from medium resolution observation of (OI)6300, (3) spectra of H2O(+) emissions in order to study the ionized component of the coma, (4) spatial distribution of H2O(+) emission features from sequences of velocity resolved images (data cubes), and (5) spatial distribution of (OI)6300 and NH2 emissions from medium resolution images. The field of view on the sky was 10.5 arcminutes in diameter. In the imaging mode the CCD was binned 4 by 4 resulting in 7.6 sec power pixel and a subarray readout for a field of view of 10.5 min. Author

**N91-21022*#** McDonald Observatory, Austin, TX.
**THE NEAR ULTRAVIOLET SPECTRA OF COMETS P/BRORSEN-METCALF AND AUSTIN**
William D. Cochran, C. R. ODell, C. O. Miller (Rice Univ., Houston, TX.), Anita L. Cochran, C. B. Opal, D. Valk, and E. S. Barker *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 50-54 (For primary document see N91-21012 12-90)
(Grants NAGw-1477; NAG5-29451; NSF AST-89-12869)
Avail: NTIS HC/MF A09 CSCL 03B

Results are reported on spectrophotometric observations of comets P/Brorsen-Metcalf and Austin from 3000 to 3600 A at a spectral resolution of about 1.8 A. The strongest features are the OH(A-X) 0-0 and 1-1 bands, and the NH(A-X) 0-0 bands. For the first time, the OH(A-X) 0-1 band was clearly found. The existence of the CN(B-X) 2-1 and 3-2 bands were verified and measured. A feature at 3258 A that was first seen in uncalibrated spectra was detected, and was identified as the NH singlet (c-a) 0-0 transition. The CO2(+) features at 3378, 3504, and 3512 A were also firmly identified. This ion was reported as being present in the tail of Comet Bester (1984 I) by Swings and Page (1950). The identification of a weak feature at 3547 A was proposed as the fundamental transition of H2CO, which would make this the first optical cometary detection of this molecule which is very abundant in giant molecular clouds. Author

**N91-21023*#** Johns Hopkins Univ., Baltimore, MD. Dept. of Physics and Astronomy.
**ROCKET OBSERVATIONS OF THE ULTRAVIOLET SPECTRUM OF COMET AUSTIN (1989c1)**
D. J. Sahnow, P. D. Feldman, S. R. McCandliss, and M. E. Martinez *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 55-58 (For primary document see N91-21012 12-90)
(Grant NAG5-619)
Avail: NTIS HC/MF A09 CSCL 03B

Long slit ultraviolet spectra of Comet Austin (1989c1) were obtained from a sounding rocket experiment launched from White Sands Missile Range, New Mexico, on 21 April 1990 at 1015 UT. The instrument, known as the Faint Object Telescope, consisted of f/15.5 Dall-Kirkham telescope, a Rowland Circle spectrograph and a microchannel plate intensifier coupled to a Reticon diode array. An onboard television camera transmitted images to the ground during flight, which permitted real-time maneuvers in order to center the comet in the entrance slit. The comet was held near the center of the slit for approximately 270 seconds by sending six pointing corrections, all but one of which was less than 30 arcseconds. The comet's parameters at the time of observation, along with the characteristics of the instrument, are given.
Author

**N91-21024*#** Johns Hopkins Univ., Baltimore, MD.
**IUE OBSERVATIONS OF COMETS P/BRORSEN-METCALF AND OKAZAKI-LEVY-RUDENKO**
E. E. Roettger, P. D. Feldman, S. A. Budzien, Mike F. AHearn, and M. C. Festou (Observatoire de Besancon, France ) *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 59-63 (For primary document see N91-21012 12-90)
(Grants NsG-5393; NAG5-252)
Avail: NTIS HC/MF A09 CSCL 03B

Comet P/Brorsen-Metcalf (1989c) was observed with the International Ultraviolet Explorer (IUE) on several dates from 27 July 1989 through 5 August 1989; comet Okazaki-Levy-Rudenko (1989r) was observed in low dispersion with IUE on 2 and 22 December 1989. The water production rates for P/Brorsen-Metcalf were derived from OH measurements using the vectorial model of Festou (1981). Included also are the water production rates for Okazaki-Levy-Rudenko. Two estimates of the water production rate from the O I emission around 1304 A(octogons) are included. The ultraviolet continuum was not reliably measurable in comet P/Brorsen-Metcalf in most of the spectra, but Afp is approximately 30 cm for 2 August. For the comet Okazaki-Levy-Rudenko, an Afp = 50 cm was derived for 22 December. Both comets have very little dust compared to other recently observed comets. The ratio of CS to water production rates are presented. Relative to water, both comets had less CS than P/Halley in the same range of heliocentric distances. The CS production rates were obtained from a Haser model, assuming a short-lived parent (CS2). Because the dynamic range of the IUE spectrographs are limited, not all species can be measured in each spectrum. The P/Brorsen-Metcalf spectra from 31 July and 3 August were obtained from the NSSDC Archives. Due to the observing technique used for these spectra, the exposure time and hence, the brightnesses and derived quantities have a small uncertainty associated with them. B.G.

**N91-21025*#** Johns Hopkins Univ., Baltimore, MD.
**IUE OBSERVATIONS OF COMET AUSTIN (1989c1)**
S. A. Budzien, P. D. Feldman, E. E. Roettger, Mike F. AHearn, and M. C. Festou (Observatoire de Besancon, France ) *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 64-68 (For primary document see N91-21012 12-90)
(Grants NsG-5393; NAG5-252)
Avail: NTIS HC/MF A09 CSCL 03B

Observations of comet Austin (1989c1) were made using the International Ultraviolet Explorer (IUE) satellite on December 22, 1989 (preperihelion) and on nine dates between 7 and 24 May, 1990 (postperihelion). A summary of observation dates and parameters is given. The ultraviolet spectrum is characteristic of that of non-dusty comets. Some preliminary results are presented for OH and CS production rates and dust-reflected solar continuum emission based upon the long wavelength, low resolution mode spectra; photometry using the IUE Fine Error Sensor; a detection of the CO fourth positive system in the short wavelength, low dispersion spectra; and an upper limit on S2. Author

**N91-21026*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**INFRARED SPECTROSCOPY OF COMETS Abstract Only**
Michael A. DiSanti, M. J. Mumma, S. M. Hoban, D. Reuter, F. Espenak, A. D. Storrs, J. Lacy, R. Parmar, and R. Joyce (Kitt Peak National Observatory, Tucson, AZ.) *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 69 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

An observational search for cometary parent molecules using infrared spectroscopy was conducted in the 1 to 5 micron region. The investigation involved two different observing programs, one at moderate spectral resolution and one at fairly high resolution. The lower resolution was used to study cometary spectra in the vicinity of 3.5 micron at wavelength/change in wavelength is approximately or equal to 10(exp 3). Comets P/Brorsen-Metcalf (1989o), Okazaki-Levy-Rudenko (1989r), and Austin (1990c1) were observed with the Cryogenic Spectrometer (CRSP) at Kitt Peak. The detector incorporated an InSb array with 58 spatial elements, each 2.7 min on the sky, and 62 spectral channels per spatial element. An, as yet, unidentified feature was detected at approximately 3.52 micron in Comet Austin (on 1990 May 4, 5, and 6). The feature is possibly present in P/Brorsen-Metcalf (observed on 1989 August 23 and 25), as well. Comet Okazaki-Levy-Rudenko exhibited continuum emission only in this spectral region at the time of the observations (1989 November 14 and 16). The data are presented, and the relationship between the 3.52 micron feature and cometary activity (e.g., water production rate, visibility of the 3.4 micron emission feature) are discussed. The high resolution program probed comet Austin in the 4.8 micron region. These observations were used to search for emission lines comprising the (1-0) vibration-rotation band of the ground electronic state of CO. Retrieval of the lines allows a probe of the population distribution of levels J' = 1 through 4 of the excited (v' = 1) vibrational state within the ground electronic state of CO. Knowledge of this distribution can be used to constrain the rotational temperature. Preliminary analysis suggests the P3 line was present UT May 16 at roughly the 5 sigma level. Results concerning the existence of other lines, and physical conditions inferred therefrom are discussed. Author

**N91-21027*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**COMPARISON OF P/BRORSEN-METCALF AND P/HALLEY IN THE THERMAL INFRARED**
David K. Lynch, Ray W. Russell, Martha S. Hanner, and David J. Lien (Bucknell Univ., Lewisburg, PA.) *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 70-74 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

Of the periodic comets, only comets Halley and Brorsen-Metcalf have periods of the order of 75 years and are bright enough to study spectroscopically in the infrared. Thermal IR spectroscopy of comet P/Brorsen-Metcalf near perihelion are presented and the results are compared to comet P/Halley. Author

**N91-21028*#** Observatoire de Paris-Meudon (France).
**OH RADIO OBSERVATIONS OF COMETS P/BRORSEN-METCALF (1989o), OKAZAKI-LEVY-RUDENKO (1989r), AARSETH-BREWINGTON (1989a1), AND AUSTIN (1989c1) AT THE NANCAY RADIO TELESCOPE**
D. Bockelee-Morvan, J. Crovisier, E. Gerard, and G. Bourgois *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 75-79 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

The 1667 MHz and 1665 MHz transitions of the OH radical were recently monitored in several comets with the Nancay radio telescope: P/Brorsen-Metcalf (1989o) (August 4 to October 31, 1989), Okazaki-Levy-Rudenko (1989r) (October 3 to December 2, 1989), Aarseth-Brewington (1989a1) (December 8 to 30, 1989), and Austin (1989c1) (February 15 to June 14, 1990). Present gas expansion measurements obtained from the analysis of the line shapes are presented and the long term variations of the water production rate, as measured from the OH radio lines. On October 13, 1989, the occultation of a background source by comet Okazaki-Levy-Rudenko (1989r) was fortuitously observed. A preliminary report of this observation is given. Further analysis of the data is continuing. Author

**N91-21029*#** Instituto de Radioastronomia, Granada (Spain).
**MILLIMETRE OBSERVATIONS OF COMETS P/BRORSEN-METCALF (1989o) AND AUSTIN (1989c1) WITH THE IRAM 30-m RADIO TELESCOPE**
P. Colom, D. Despois, D. Bockelee-Morvan, J. Crovisier (Observatoire de Paris-Meudon, France ), and G. Paubert *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 80-85 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

Millimeter observations with the IRAM 30 m telescope were conducted in comet P/Brorsen-Metcalf (1989o) on September 1989 and Austin (1989c1) on April and May 1990. The HCN J(1-0) and J(3-2) lines were detected in both comets. The HCN production rate relative to water in P/Brorsen-Metcalf is comparable to that previously measured in comet P/Halley, while that inferred in comet Austin might be smaller by a factor of two. The H2CO(3 sub 12 - 2 sub 11) transition, marginally observed in comet P/Brorsen-Metcalf, was firmly detected in May 1990 in comet Austin. Observations performed at offset positions suggest that the source of H2CO might be distributed. The H2CO abundance is on the order of 0.5 percent that of water for both comets, assuming a scalelength of 10(exp 4) km at 1 AU from the Sun for the distributed source. During the May observing period of comet Austin, two new species were detected for the first time in a comet: hydrogen sulfide (H2S) through its 1(sub 10) - 1(sub 01) ortho line at 169 GHz, and methanol (CH3OH) through J(3-2) delta K = 0 transitions at 145 GHz. Preliminary estimates of their abundances are 1.5 x 10(exp -3) for H2S and 8 x 10(exp -3) for CH3OH. Author

**N91-21030*#** Illinois Univ., Urbana. Dept. of Astronomy.
**VLA SEARCHES FOR FORMALDEHYDE AND CYANOACETYLENE EMISSION FROM COMET P/BRORSEN-METCALF (1989o)**
Lewis E. Snyder, Patrick Palmer, and Imke dePater (California Univ., Berkeley.) *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 86-91 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

In Sep. 1989, Very Large Array (VLA) searches were conducted for both formaldehyde (H2CO) and cyanoacetylene (HC3N) emission from Comet P/Brorsen-Metcalf (1989o). In early July, this comet was outgassing strongly at a brighter than average preperihelion rate, and the hope was that it would continue to do so through perihelion. By observing the 1 sub 11 to 1 sub 10 transition of H2CO at 4,829.659 MHz (6 cm lambda) during the phase of maximum outgassing, it was expected that spectra would be collected with a high signal to noise ratio which would show the temporal behavior of formaldehyde relative to other molecules. During this same observation period, a search was also made for the J-1-0, F-2-1 rotational transition of cyanoacetylene at 9098.3321 MHz (3.3 cm lambda). Author

**N91-21031*#** Aerospace Corp., Los Angeles, CA. Space Sciences Lab.
**SILICATES AND VARIABILITY IN COMETS OKAZAKI-LEVY-RUDENKO (1989r) AND AUSTIN (1989c1)**
Ray W. Russell and David K. Lynch *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 92-96 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

Comet Okazaki-Levy-Rudenko (1989r) was studied over a wide range of wavelengths from the UV to the submillimeter. Using visual magnitude estimates from the IAU Circulars and reported submillimeter fluxes in conjunction with the thermal infrared

spectroscopy and filter photometry, the nature of the grains and the behavior of the comet can be assessed and compared to other comets studied under this program. In addition, preliminary results from a collaborative infrared study of Comet Austin are presented which address the nature of the dust in that comet. Progress on a model for cometary properties and brightness behavior is discussed. Author

**N91-21032*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**DETECTION OF THE 3.4 MICRON EMISSION FEATURE IN COMETS P/BRORSEN-METCALF AND OKAZAKI-LEVY-RUDENKO (1989r) AND AN OBSERVATIONAL SUMMARY**
T. Y. Brooke, A. T. Tokunaga (Hawaii Univ., Honolulu.), and R. F. Knacke *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 97-101 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

A survey was performed of the 3 micron spectral region of comets, including the broad 3.4 micron emission feature due to C-N bonds in organic molecules. One goal is to determine how the strength of the emission band varies with heliocentric distance r in comets. This depends on both the production rate of the organic molecules and the emission mechanism, neither of which is well determined at present. The observations to date are consistent with cometary organics being present in all comets at comparable abundances relative to water. Loss of contrast in the 3.4 micron feature as comets get closer to the sun is then easily explained by dilution by thermal emission from the continuum grains, whose flux rises more steeply with heliocentric distance than that of organics. Author

**N91-21033*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**COMET BROPSEN-METCALF IN THE 3.5 MICRON REGION Abstract Only**
A. D. Storrs (Texas Univ., Austin.), M. J. Mumma, and S. M. Hoban *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 102 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

Comet Brorsen-Metcalf was observed on UT 21 to 24 Aug. 1989 using the CRSP spectrometer and the 1.3 meter telescope at Kitt Peak National Observatory. The cometary continuum was detected on all nights. The data are very noisy, due to the short observation window and the untried nature of the instrument. Low resolution (0.0227 micron) spectra show the 3.4 micron C-H stretch feature having a contrast of at most a factor of two to the neighboring continuum. High resolution (0.0031 micron) spectra between 3.4 and 3.6 microns show 1 sigma features that might be attributed to the nu 5 band of formaldehyde (H2CO). Similar spectra of the region between 3.2 and 3.4 microns show one 3 sigma line at 3.34 microns, which is as yet unidentified. Although the cometary spectra were more spatially extended than the spectra of standard stars, no extension of the line emission beyond the continuum was observed. Author

**N91-21034*#** Arizona State Univ., Tempe. Dept. of Physics and Astronomy.
**CARBON ISOTOPES IN COMETS**
Peter A. Wehinger *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 103-109 Sponsored in part by NSF (For primary document see N91-21012 12-90)
(Grant NAGw-547)
Avail: NTIS HC/MF A09 CSCL 03B

The progress is reported of high resolution spectra of selected bright comets with the aim of determining the carbon isotope abundance ratio, C-12/C-13. The ratio was determined for various Solar System objects (in the atmospheres of the giant planets, meteorites, the Earth, and the solar photosphere), where the C-12/C-13 = 89/1. In the interstellar medium, optical and radio observations give a range of C-12/C-13 = 43-67/1 depending on the observing techniques used and the specific interstellar cloud observed. The echelle spectra is presented of the CN(0,0) violet system in three comets: P/Brorsen-Metcalf, C/Okazaki-Levy-Rudenko, and C/Austin. P/Brorsen-Metcalf has a period of 70 y (prograde) compared with P/Halley which is 76 y (retrograde). The similar periods made P/Brorsen-Metcalf of special interest for comparison with P/Halley. Author

**N91-21035*#** Arizona State Univ., Tempe. Dept. of Physics and Astronomy.
**N2H(+) IN WARM AND COLD CLOUDS**
Maria Womack *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 110-115 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

A topic of importance in both cometary and instellar astronomy is the N2/NH3 abundance ratio in star forming regions. A key test for solar system formation models is the N2/NH3 abundance ratio in comets, which are thought to be made up of material from the protostar nebula, and in molecular clouds, from which stars are thought to be approx. 0.1. The N2/NH3 abundance ratio has never been measured in the interstellar medium, but is estimated from theoretical models to be in the range of 100 to 200. If the theoretical models are truly representative of dense molecular clouds then the difference in the abundance ratios of N2/NH3 between comets and the ISM would imply that significant chemical processing must have occurred in the protostar nebula that somehow altered the amount of N2 relative to NH3. A systematic survey was made of star forming regions to establish N2 abundances and N2/NH3 ratios for comparison with cometary data. Author

**N91-21036*#** Arizona State Univ., Tempe. Dept. of Physics and Astronomy.
**SPECTRUM SYNTHESIS OF CN IN COMETS**
Marvin Kleine *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 116-120 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

The CN B-X (0-0) R branch fluorescence spectra for three comets (Austin, Bennett, Halley) were calculated and compared to the observed spectra. The synthesized spectrum in each case was shifted to allow for the comparison of the individual line intensities. The Swings effect (excitation of CN band in comet spectra by solar fluorescence) is clearly visible. In addition to the R(0-0) band in the CN spectrum, the P(1-1) band also contributes lines in the spectral region of observation. This branch was calculated and compared to P/Halley. The overall agreement between observations and the CN spectral model is quite good. An exception to this statement would be the high J rotation lines intensities within the R(0-0) branch of P/Halley. Additional analysis is necessary to determine if this difference is due to mechanisms in addition to fluorescence (e.g., collisions). Author

**N91-21037*#** Arizona Univ., Tucson. Lunar and Planetary Lab.
**NEAR-NUCLEUS H2O(+) STRUCTURES IN COMETS BRORSEN-METCALF, OKAZAKI-LEVY-RUDENKO, AND AUSTIN**
Stephen M. Larson *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 121-127 (For primary document see N91-21012 12-90)
(Grant NAGw-247)
Avail: NTIS HC/MF A09 CSCL 03B

Comets P/Brorsen-Metcalf, Okazaki-Levy-Rudenko, and Austin were all observed to have well developed H2O+ structure close to the nuclei that showed changes on a time scale of only a few minutes. Some preliminary data on the observed ion morphology and their evolution is presented. Author

**N91-21038*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**A TAIL-WAGGING EVENT IN COMET AUSTIN**

Daniel A. Klinglesmith, Malcolm B. Niedner, Ronald J. Oliversen, and David Westpfahl (New Mexico Inst. of Mining and Technology, Socorro.) *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 128-136 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

On the morning of 21 May 1990, a sequence of images of Comet Austin was obtained in the light of H2O+. The filter was centered at 602.5 nm with FWHM of 5.0 nm. At least two waves were followed out through the main ion tail structure. During the course of the observations, 2.5 hours, two new tail rays were seen to form and undergo similar wave motion. Several condensations, possibly representing disconnected material, were seen to develop and move out along the tail ray with a velocity of about 60 km/sec. Author

**N91-21039*#** Tohoku Univ., Sendai (Japan). Geophysical Inst.
**DISTURBANCES OF THREE COMETARY MAGNETOSPHERES AS EXPLAINED BY AN MHD SIMULATION**
Y. Kozuka, T. Saito, Ichishiro Konno (Southwest Research Inst., San Antonio, TX.), and T. Oki *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 137-141 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

Outstanding disturbances of the plasma tails were observed in 1989 in three comets, Brorsen-Metcalf, Okazaki-Levy-Rudenko, and Aarseth-Brewington. Time variations of the tails were obtained from photographs provided by many astronomers. A 2-D MHD simulation was performed varying the speed and the direction of the solar wind flow. The simulation agreed quite well with the observations. Solar flares were identified as the sources of these disturbances. It was found that the sudden change in direction of the plasma tail axis occurs when the comet crosses a discontinuity surface of the solar wind structure accompanied by solar flares. Author

**N91-21040*#** California Univ., Davis. Dept. of Chemistry.
**RADICAL FORMATION IN THE COMA FROM PHOTODISSOCIATION OF ICE GRAINS Abstract Only**
William M. Jackson and Christopher Gerth *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 142 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

Long ago visual observations of comets suggested that there are jets in comets but it has only been recently that A'Hearn et al. have proven that some of these jets are due to emission from the CN radical. Recent studies in the lab have shown that CN radicals can be ejected directly into the gas phase from the photolysis of frozen vapors if the parent molecular has been excited to repulsive excited state. This later observation suggests that the jets that have been observed may be due to photodissociation of icy grains in the coma. A theory of radical formation from icy grains is presented. It is shown that direct formation of free radicals in the coma is an effective way to produce radicals from icy grains in the coma. The model predicts that icy grains could produce from 6 to 800,000 OH radicals/s per grain depending upon whether the radius of the grain is 0.3 to 100 micron. Author

**N91-21041*#** VF Associates, Washington, DC.
**AN ALTERNATIVE TO THE DIRTY SNOWBALL MODEL OF COMETS**
Tom C. VanFlandern *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 144-149 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

To be viable, a scientific theory or model must not be contradicted by observations or experiments. To be useful, a model must explain some phenomenon and aid the understanding of it. By these criteria, the Dirty Snowball model for the nature of comets is now on shaky ground. By contrast, the Satellite Model easily passes all these measures of the worth of a theory. Briefly, in the Satellite Model, comets consist of a cloud of asteroid-like debris of all sizes, which is gravitationally bound together. Comet tails are formed when solar radiation pressure drives gas and dust away. Each important physical characteristic is review of comets, and how it fits into each model. Author

**N91-21042*#** Southwest Research Inst., San Antonio, TX.
**MODELING THE DUST SIZE DISTRIBUTION IN COMETS WITH DUST FRAGMENTATION**
Ichishiro Konno and Walter F. Huebner *In its* Workshop on Observations of Recent Comets (1990) 1990 p 150-154 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

A hydrodynamic model was developed of a spherically symmetric dusty gas flow in a cometary atmosphere assuming a single fluid, inviscid, perfect gas. The hydrodynamics for gas and dust, which involves the gas drag force (momentum transfer), heat exchange between gas and dust, photodissociation energy for H2O gas, and radiative heating and cooling terms for dust particles, are solved using the Gear method for stiff, coupled differential equations. Calculations were done with a dust size distribution for radii alpha = 0.01 micron to 10 cm with densities variable with the size. A nucleus size of 4.0 km radius with a density of 0.5 g/cu cm and a total dust-to-gas mass ratio chi = 1 was adopted. There are indications from in situ observations that dust particle fragment into smaller ones. Fragmentation of dust particles was incorporated into the model. This is done by adding source and sink terms in the continuity equations for the dust. Lifetimes for the decay of dust particles were assumed as a function of particle size. It is also assumed that dust particles always fragment only into the next smaller size. Author

**N91-21043*#** Southwest Research Inst., San Antonio, TX.
**A MODEL OF MULTIGENERATION NEUTRALS IN COMETARY COMAE**
Dan C. Boice (Max-Planck-Inst. fuer Astrophysik, Garching, Germany, F.R. ) *In its* Workshop on Observations of Recent Comets (1990) 1990 p 155-159 Sponsored in part by Max-Planck-Gesellschaft (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

The spatial distribution of neutral species in the outer coma of a comet is described using a modified version of the fountain model. This model accounts for neutrals that are produced in multiple generations after release from the nucleus (or production in the collision zone of the inner coma) by an iterative application of the fountain model. A preliminary description of the model is given; however, results are presented in a future paper. Suitable applications of the model include the following: (1) distributed coma sources of neutral gas phase species from anisotropic dust emission; (2) the description of cometary comae at large heliocentric distances; and (3) day/night asymmetry of gas production from the nucleus. Author

**N91-21044*#** Arizona State Univ., Tempe. Dept. of Physics and Astronomy.
**A MULTIGENERATIONAL MONTE CARLO MODEL OF A COMET COMA**
Anthony J. Ferro *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 160-165 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

A steady state multigenerational Monte Carlo model was developed to describe the distribution of a neutral coma species which was produced after several photodissociation steps. This distribution can be compared with either line profiles derived from long slit spectroscopic observations or narrow band imaging, and be used to determine the elemental abundances present in the comet coma. A Monte Carlo model was chosen due to limitations in standard forms of more analytic models, such as those of Haser and Festou. In contrast to the analytical models, the Monte Carlo method can be modified to include new physical parameters. Author

**N91-21045*#** New Mexico Univ., Albuquerque.
**A QUASI-LINEAR THEORY TO EXPLAIN ION ACCELERATION IN THE DISTANT COMETARY ENVIRONMENT Abstract Only**
Raji Sinha, S. Peter Gary (Los Alamos Scientific Lab., NM.), and Norman Roderick *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 166 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

Spacecraft observations at comet Halley as well as computer simulations have shown that pitch angle scattering of newborn cometary ions proceeds at a relatively fast rate, leading to relatively isotropic shell-like velocity distribution functions. Energization processes whereby shell distributions become more Maxwellian and a few ions are accelerated to high energies appear to proceed more slowly. The research on the latter, slower process is described, in which the scattering is assumed to be due to the resonant, growing magnetic fluctuations driven by the non-Maxwellian nature of the ion distribution. An ion shell distribution which is isotropic in the wave frame begins the process and a Fokker-Plank derived from quasilinear plasma theory is used to describe the broadening and energization of the cometary ion distribution. Author

**N91-21046*#** New Mexico State Univ., Las Cruces. Dept. of Mathematical Sciences.
**MODELS OF THE SPIN STATE OF THE COMET HALLEY NUCLEUS**
William H. Julian *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 167-171 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

Eight rotation precession models of the comet Halley nucleus have been proposed by eight authors. The eight models were evaluated in relation to the constraints imposed by: (1) the observed long axis directions at the Vega 1, Vega 2, and Giotto encounters; (2) the ground based emission periods harmonically related to 7.4 days; (3) the need for a two day spin period in the analysis of the jet morphology; (4) the Smith et al. constraint on the net long axis roll between Vega 2 and Giotto; (5) the resistance of the spin state of the nucleus to change due to the torque from the jets; and (6) the 7.4 day repetition of the spatial orientation of the nucleus. The eight constraints are briefly described. Author

**N91-21047*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena. Earth and Space Sciences Div.
**THE CRAF MISSION AND EARTH-BASED COMET OBSERVATIONS**
Paul R. Weissman and Marcia Neugebauer *In* Southwest Research Inst., Workshop on Observations of Recent Comets (1990) 1990 p 172-173 (For primary document see N91-21012 12-90)
Avail: NTIS HC/MF A09 CSCL 03B

The Comet Rendezvous Asteroid Flyby (CRAF) mission is now being designed and planned to perform detailed studies of a typical short period comet as it moves around its orbit, building on the data gained from the Giotto, Vega, and Suisei fast flybys of Comet Halley in 1986. CRAF will be launched in Aug. 1995 and will match orbits with short period Comet Kopff in July 2000, 850 days before perihelion at a heliocentric distance of 5.05 AU. After a series of close, slow flybys, the spacecraft will be placed in orbit around the nucleus for a better than 1 m/line-pair imaging resolution on the nucleus surface. Earth based observations of the target comet, either by ground based facilities or Earth orbiting satellites, can provide essential data for CRAF mission planning, and are needed in support of the rendezvous mission. Estimates of the nucleus size, albedo, shape, rotation period, and rotation pole orientation are needed for preliminary mission planning, resource allocation, and sequence design. Author

**N91-21048#** Mission Research Corp., Santa Barbara, CA.
**SPECIFICATION OF IRAS CONFUSED REGIONS Report, 11 Jan. - 11 May 1990**
J. P. Kennealy, C. E. Woodward, and R. M. Korte 19 Jun. 1990 70 p
(Contract F19628-90-C-0110)
(AD-A230568; GL-TR-90-0165; SR-1) Avail: NTIS HC/MF A04 CSCL 03/2

This document reports on the efforts to define the IRAS confused regions. The subset will be limited by the availability of survey data in the regions which are identified as point source confused by the current (Ver 2.0) IRAS point source catalog (PSC). Available coincident AO data will be an important validation source. The sensitivity and spatial resolution capabilities of the IRAS telescope failed to resolve individual sources in many regions of high source density. Approximately 10 percent of the sources catalogued in the PSC are tagged as 'confused' in some way; the location of a source, the number of sources at a location, the temporal occurrence and variation of a source, and/or the intensity of a source(s) was not discernible by the source identification/discrimination methods used to compile the PSC. In these regions of infrared clutter, the PSC can underestimate the number of point sources by as much as a factor of 3 to 5 in the IRAS Bands 1 and 2 (12 and 25 microns respectively). Analysis for improved source counts is designed to enhance the description and spatial definition of the mid- and long-wavelength infrared celestial background, and includes generation of high spatial resolution images of the confused regions. Analysis of these images will improve the accuracy of source counts, locations, and flux estimates in the PSC. More detailed knowledge of the high source density regions will improve our ability to understand star formation and galactic evolution. GRA

# 91 LUNAR AND PLANETARY EXPLORATION

Includes planetology; and manned and unmanned flights.

For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

**N91-21049#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**NUMERICAL ANALYSIS OF CRITICAL INCLINATIONS ABOUT THE PLANET MARS M.S. Thesis**
Kenneth J. Hyatt 20 Nov. 1990 113 p
(AD-A230613; AFIT/GA/ENY/90D-8) Avail: NTIS HC/MF A06 CSCL 03/3

This study investigated critical inclinations about the planet Mars. Averaged equations of motion were numerically integrated over a time span of ten earth years for various inclinations, eccentricities, and perigee heights. Each orbit (i.e., set of initial conditions) produced a standard deviation of the variations in eccentricity (SDE) and inclination (SDI). These were calculated using a polynomial approximation to the variations. Surface plots of SDI and SDE vs. the initial conditions are then examined to ascertain the critical inclinations. GRA

**N91-21050#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**MINIMUM ORBITS ABOUT THE PLANET VENUS M.S. Thesis**
Jeffrey J. Smith Nov. 1990 77 p
(AD-A230756; AFIT/GA/ENY/90D-12) Avail: NTIS HC/MF A05 CSCL 03/3

An investigation is conducted into low orbiting satellites around the planet Venus with drag limited lifetimes. It is possible to specify combinations of orbital elements which result in orbital lifetimes in excess of some desired value. These combinations can be assembled into Critical Curves and Critical surfaces. Critical Curves and Surfaces are defined as curves and surfaces in orbital element space above which initial element sets will result in orbits that meet or exceed lifetime requirements. A numerical method is implemented for finding these combinations, and three Critical Surfaces are examined. A decay threshold is selected for bounding satellite lifetime. Numerical simulations are conducted, and polynomials describing the Critical Curves are produced for five eccentricities at each of three decay threshold values. Comparisons

are made of the effects of the different perturbations considered (geopotential, atmospheric drag, third body effects due to the sun, and solar radiation pressure). GRA

**N91-21051*#** Atmospheric and Environmental Research, Inc., Cambridge, MA.
**THE HEMISPHERICAL ASYMMETRY OF THE RESIDUAL POLAR CAPS ON MARS Semiannual Progress Report, 1 Sep. 1989 - 1 Mar. 1991**
Bernhard Lee Lindner 1 Mar. 1991 80 p
(Contract NASw-4444)
(NASA-CR-188100; NAS 1.26:188100) Avail: NTIS HC/MF A05 CSCL 03B

A model of the polar caps of Mars was created which allows: (1) for light penetration into the cap; (2) ice albedo to vary with age, latitude, hemisphere, dust content, and solar zenith angle; and (3) for diurnal variability. The model includes the radiative effects of clouds and dust, and heat transport as represented by a thermal wind. The model reproduces polar cap regression data very well, including the survival of CO2 frost at the south pole and reproduces the general trend in the Viking Lander pressure data. Author

**N91-20157#** Joint Publications Research Service, Arlington, VA.
**GLOBAL CIRCULATION OF VENUSIAN ATMOSPHERE Abstract Only**
M. N. Izakov *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 33 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 28, no. 3, May - Jun. 1990 p 451-458 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

**N91-20158#** Joint Publications Research Service, Arlington, VA.
**PRELIMINARY ANALYSIS OF VENUSIAN TECTONICS AND EVOLUTION Abstract Only**
A. M. Nikishin *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 33 Transl. into ENGLISH from Geotektonika (Moscow, USSR), no. 3, May - Jun. 1990 p 16-27 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

**N91-20159#** Joint Publications Research Service, Arlington, VA.
**HOMOGENEOUS DISTRIBUTION OF VOLCANIC FLOWS IN THE NORTHERN HEMISPHERE OF VENUS Abstract Only**
G. A. Leykin, V. K. Vorozdin, and Ye. V. Zabaluyeva *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 33 Transl. into ENGLISH from Astronomicheskiy Vestnik (Moscow, USSR), v. 24, no. 3, Jul. - Sep. 1990 p 195-202 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

**N91-20160#** Joint Publications Research Service, Arlington, VA.
**SULFURIC ACID IN VENUSIAN ATMOSPHERE DETERMINED FROM RADIO OPACITY DATA Abstract Only**
S. S. Matyugov, O. I. Yakovlev, and V. N. Gubenko *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 35 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 28, no. 2, Mar. - Apr. 1990 p 277-281 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

**N91-20161#** Joint Publications Research Service, Arlington, VA.
**DEVELOPMENT OF MODEL OF FORMATION OF VENUSIAN NIGHTTIME IONOSPHERE FOR PERIOD OF LOW SOLAR ACTIVITY Abstract Only**
L. N. Samoznayev *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 35 Transl. into ENGLISH from Kosmicheskiye Issledovaniya, (Moscow, USSR), v. 28, no. 2, Mar. - Apr. 1990 p 282-292 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

**N91-20162#** Joint Publications Research Service, Arlington, VA.
**ELECTRIC FIELDS, DYNAMICS OF SO2 CONCENTRATION, POSSIBLE VULCANISM ON VENUS Abstract Only**
L. V. Ksanfomaliti *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 35-36 Transl. into ENGLISH from Astronomicheskiy Vestnik (Moscow, USSR), v. 24, no. 1, Jan. - Mar. 1990 p 59-71 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

**N91-20163#** Joint Publications Research Service, Arlington, VA.
**THE GRAVITATIONAL FIELD ON THE PHYSICAL SURFACE OF VENUS Abstract Only**
T. G. Maksimova and N. A. Chuykova *In its* JPRS Report: Science and Technology. USSR: Space 26 Nov. 1990 p 36 Transl. into ENGLISH from Kinematika i Fizika Nebesnykh Tel (Kiev, USSR), v. 6, no. 1, Jan. - Feb. 1990 p 19-27 Original language document was announced in IAA as A90-26385 (For primary document see N91-20154 12-12)
Avail: NTIS HC/MF A06

**N91-20669*#** Carnegie-Mellon Univ., Pittsburgh, PA. Robotics Inst.
**A PERCEPTION AND MANIPULATION SYSTEM FOR COLLECTING ROCK SAMPLES**
T. Choi, H. Delingette, M. DeLuise, Y. Hsin, M. Hebert, and Katsushi Ikeuchi *In* NASA, Lyndon B. Johnson Space Center, Fourth Annual Workshop on Space Operations Applications and Research (SOAR 90) Jan. 1991 p 226-233 (For primary document see N91-20641 12-59)
(Grant NAGw-1175)
Avail: NTIS HC/MF A21 CSCL 03B

# 92 SOLAR PHYSICS

Includes solar activity, solar flares, solar radiation and sunspots.

For related information see *93 Space Radiation.*

No abstracts in this category.

# 93 SPACE RADIATION

Includes cosmic radiation; and inner and outer earth's radiation belts.

For biological effects of radiation see *52 Aerospace Medicine.* For theory see *73 Nuclear and High-Energy Physics.*

**N91-21052*#** California Inst. of Tech., Pasadena.
**BEVALAC STUDIES OF MAGNET CERENKOV SPECTROSCOPY Final Report**
5 Apr. 1991 24 p
(Grant NAG5-878)
(NASA-CR-188064; NAS 1.26:188064) Avail: NTIS HC/MF A03 CSCL 03B

The attempt was made to identify the various contributions to the velocity resolution of Cerenkov detectors such as might be used in Astromag, to measure the magnitude of these contributions and assess their effect on the mass resolution of an isotope spectrometer for Astromag, and to perform Bevalac tests of magnet/Cerenkov spectroscopy. A first version of a new 5 in. photomultiplier tube was also tested that is designed for use in large magnetic fields. Y.S.

**N91-21053#** Lawrence Livermore National Lab., CA.
**LINE AND CONTINUUM SPECTROSCOPY AS DIAGNOSTIC TOOLS FOR GAMMA RAY BURSTS**
E. P. Liang Dec. 1990 17 p Presented at the Gamma-Ray

Line Astrophysics Symposium, Paris, France, 10-13 Dec. 1990
(Contract W-7405-eng-48)
(DE91-008062; UCRL-JC-105999; CONF-901275-1) Avail: NTIS HC/MF A03

We review the theoretical framework of both line and continuum spectra formation in gamma ray bursts. These include the cyclotron features at 10's of keV, redshifted annihilation features at approximately 400 keV, as well as other potentially detectable nuclear transition lines, atomic x-ray lines, proton cyclotron lines and plasma oscillation lines. By combining the parameters derived from line and continuum modeling we can try to reconstruct the location, geometry and physical conditions of the burst emission region, thereby constraining and discriminating the astrophysical models. Hence spectroscopy with current and future generations of detectors should provide powerful diagnostic tools for gamma ray bursters. DOE

**N91-21054#** Argonne National Lab., IL.
**SIGNALS FROM COSMIC RAY SOURCES, SOME STATISTICAL ISSUES**
M. Goodman 27 Oct. 1990 5 p Presented at the 1990 DPF Summer Study on High Energy Physics, Snowmass, 25 Jun. - 13 Jul. 1990
(Contract W-31-109-eng-38)
(DE91-008727; ANL-HEP-CP-90-106; CONF-9006267-25) Avail: NTIS HC/MF A01

The possible existence of discrete sources of cosmic rays is presently one of the main topics of study in non-accelerator particle physics. The search is being conducted in a wide variety of experiments using UHE gamma rays, VHE gamma rays, EeV particles, underground mu's and nu's. The current experimental situation, however, can be described as chaotic. The number of claimed observations of sources by different groups using a variety of experimental techniques is quite large, but a consistent interpretation of the various results has failed to emerge. Most of the observations rely on either a dc excess from the direction of the source, a periodicity of the events from that direction, or some combination of these two effects. In the first section of this paper, we discuss some of the techniques that may be used in searching for a dc excess. We review two common bin free tests of the light curves. We discuss a particular problem involving phase coherence when doing a period search. This paper discusses some of the issues and meanings involved in combining probabilities from more than one test. Prescribing the right way to do analysis is certainly beyond this paper's scope. However some of the issues and problems are considered here. DOE

# 99 GENERAL

**N91-21055*#** National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
**CHRONOLOGY OF KSC AND KSC RELATED EVENTS FOR 1990**
Ken Nail, Jr. Mar. 1991 277 p
(NASA-TM-103327; NAS 1.15:103327; KHR-15) Avail: NTIS HC/MF A13 CSCL 05D

The document is intended to serve as a record of Kennedy Space Center (KSC) events and as a reference source for historians and other researchers. Arrangement is by day and month and individual articles are attributed to published sources. An index has been added to this edition. Author

**N91-21056#** Assistant Secretary of the Army (Research, Development and Acquisition), Washington, DC.
**THE 17TH ARMY SCIENCE CONFERENCE PROCEEDINGS. VOLUME 1: PRINCIPAL AUTHORS A THROUGH F**
1990 659 p Conference held in Durham, NC, 12-15 Jun. 1990
(AD-A230098) Avail: NTIS HC/MF A99 CSCL 05/2

The following subject areas are covered: Designer energetic materials; Resin modified pavement; Chemistry of solid propellant ignition; Development of vehicle woodland camouflage patterns analogous to background contrast highlights; Exertional heatstroke in soldiers - Analysis of recovery rates, predisposing factors and residual heat intolerance; Inactivated whole virus vaccine for prevention of viral hepatitis type A; Hierarchical route planner; Nonlinear metal composites for guided wave devices in optical computing; Nonlinear optical properties of metallic microparticle composites; Reaction kinetic model (PANDORA) with reaction induction times for molecular collisions; MCT solid-state switching - Revolution in power conditioning; Laser microscope using phase-conjugate reconstruction from a photorefractive hologram; Effect of crystallographic orientation on performance of single crystal tungsten sub-scale penetrators; Use of a clinically relevant uncontrolled hemorrhage model to study massive internal bleeding and to develop appropriate courses of clinical response to that hemorrhage; IV Fluidmaker - Preparation of sterile water for injection in a field setting; Potential of new army tests to improve job performance. GRA

**N91-21057#** Assistant Secretary of the Army (Research, Development and Acquisition), Washington, DC.
**THE 17TH ARMY SCIENCE CONFERENCE PROCEEDINGS. VOLUME 2: PRINCIPAL AUTHORS G THROUGH M**
1990 607 p Conference held in Durham, NC, 12-15 Jun. 1990
(AD-A230099) Avail: NTIS HC/MF A99 CSCL 05/2

The following subject areas are covered: Validation and application of a rotor acoustic prediction computer program; Induction of enhanced strains of a thermophile that synthesizes an OPA anhydrase effective in hydrolyzing 4-Nitrophenyl esters of phenylphosphinate; Hybrid approaches for spread spectrum COMINT; Optical associative memory based on binary phase algebra and the inner product architecture; Biodegradation of energetic materials; Soldier performance research project - Armor field and SIMNET tests; Identification of a novel cytokine induced effector molecule involved in the intracellular destruction of Leishmania, Franciscella and Plasmodium Sporozites - Nitric oxide; Protection from ricin toxicity by Brefeldin A; Development of topically applied anti inflammatory agents for treating acute pulpal inflammation in combat situations; Supercomputers simulation of supersonic viscous flow over pointed, spherical, and flat tipped shell; Characterization of the catalytic site for G agent hydrolysis using electron paramagnetic resonance; Vulnerability analysis of protective structures using probabilistic methods; Optically controlled dielectric resonator oscillator for millimeter wave applications; Does OPTEMPO increase unit readiness. An objective answer; A Coxiella burnetii repetitive DNA element with potential diagnostic and mutagenic capabilities; Evaluating combat soldier energy balance in the field with stable isotope and ambulatory monitoring methods. GRA

**N91-21058#** Assistant Secretary of the Army (Research, Development and Acquisition), Washington, DC.
**THE 17TH ARMY SCIENCE CONFERENCE PROCEEDINGS. VOLUME 3: PRINCIPAL AUTHORS N THROUGH Z**
1990 561 p Conference held in Durham, NC, Jun. 12-15 1990
(AD-A230100) Avail: NTIS HC/MF A24 CSCL 05/2

The following subject areas are covered: Computational fluid dynamics applications to the aerodynamic of symmetric sabot discard; Predicting target detection skill; Optical studies of the flow start-up in convergent/divergent nozzles; Directed energy warfare - advances in protective armor materials; Ranger and special forces research - implications for low intensity conflict training and operations; Acutely enhanced burn recovery by post-event non-ionic surfactant treatment in a rat model; Role of ascorbic acid and tin in maillard browning of wet-pack fruits; Layered architecture for interfacing Ada and SQL; Vehicle motion resistance due to snow; Hyperspectral imagery--A new technique for targeting and intelligence; Development of vaccines against malaria; Three dimensional flow calculations for a projectile with standard and dome bases; Finite element analysis fo the dynamic thermal buckling of a thin wall cylinder; Spectral luminescence of camouflage fabrics and paints; Excimer laser photodissociation of

selected oximes - Search for H2CN radical; Laser spectroscopic and mass spectrometric studies of propellant-like low pressure flames; Expression of Hantaan viral antigens for vaccine development; Knowledge Worker System - An investment for the Army's future; Image processing application via photorefraction; Thermal imaging at above frame rate frequencies. GRA

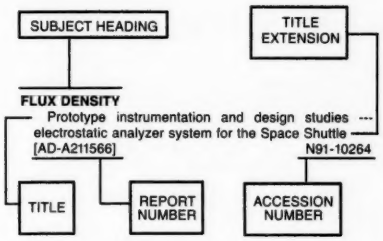
**N91-20087*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**LEWIS AEROPROPULSION TECHNOLOGY: REMEMBERING THE PAST AND CHALLENGING THE FUTURE**

Neal T. Saunders and Arthur J. Glassman *In its* Aeropropulsion 1991 Mar. 1991 21 p (For primary document see N91-20086 12-07)

Avail: NTIS HC/MF A24 CSCL 05D

## Typical Subject Index Listing




The subject heading is a key to the subject content of the document. Titles, report numbers, and accession numbers of pertinent documents are provided under each subject heading. When the title is insufficiently descriptive of the document content, a title extension has been added, separated from the title by three hyphens. The report number helps to indicate the type of document cited (e.g., NASA report, NASA translation, NASA contractor report). The accession number is the number by which the document abstracts are arranged in this journal and by which the document is sold or requested. The titles, with title extensions if present, are arranged under each subject heading in ascending accession number order. The subject headings have been selected from the latest revision of the *NASA Thesaurus* (NASA SP-7064).

## A

**ABRASION**
Effects of dust accumulation and removal on radiators surfaces on Mars
[NASA-TM-103704] N91-20204

**ABRASIVES**
Revealing the microstructure of materials N91-20220

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Survey of alternative laser sources for Backscatter Absorption Gas Imaging (BAGI)
[DE91-008444] N91-20485
Development of optical fibers with embedded gratings for sensor and signal processing applications
[AD-A229971] N91-20894

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Infrared absorption spectroscopy and chemical kinetics of free radicals
[DE91-008282] N91-20260

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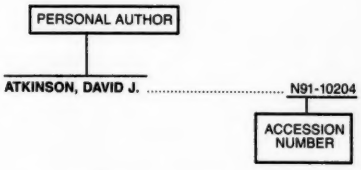


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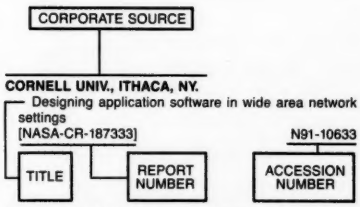


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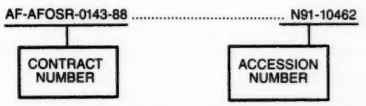


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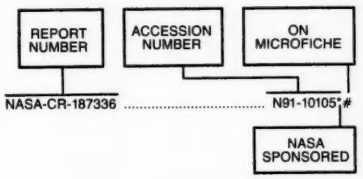


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AEDC-TR-90-25 ..... N91-20757 #
AEDC-TR-90-27 ..... N91-20187 #

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AFDTC-TR-90-48 ..... N91-20852 #

AFESC/ESL-TR-87-03 ..... N91-20333 #
AFESC/ESL-TR-89-60 ..... N91-20970 #

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AFHRL-TR-90-56 ..... N91-20835 #

AFIT/DS/ENC/90-2 ..... N91-20841 #

AFIT/DS/ENG/90D-3 ..... N91-20901 #

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AFIT/GA/ENY/90D-5 ..... N91-20495 #
AFIT/GA/ENY/90D-6 ..... N91-20409 #
AFIT/GA/ENY/90D-7 ..... N91-20194 #
AFIT/GA/ENY/90D-8 ..... N91-21049 #
AFIT/GA/ENY/90D-9 ..... N91-20179 #
AFIT/GA/ENY/90D-02 ..... N91-20173 #
AFIT/GA/ENY/90D-12 ..... N91-21050 #
AFIT/GA/ENY/90D-13 ..... N91-20190 #

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AFIT/GAE/ENG/90D-01 ..... N91-20080 #
AFIT/GAE/ENG/90D-69 ..... N91-20372 #

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AFIT/GAE/ENY/90D-28 ..... N91-20237 #
AFIT/GAE/ENY/90D-30 ..... N91-20234 #

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AFIT/GCE/ENG/90D-05 ..... N91-21000 #

AFIT/GCS/ENC/90D-1 ..... N91-20042 #

AFIT/GCS/ENG/90D-09 ..... N91-20744 #
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AFIT/GCS/ENG/90D-13 ..... N91-20767 #
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AFIT/GEP/ENP/90D-10 ..... N91-20471 #

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AFIT/GSM/LSY/90S-21 ..... N91-20999 #
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AIAA-91-0373 ..... N91-20052* #
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AL-TR-90-027 ..... N91-20320 #
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AMSMI-CR-RD-AS-90-3-VOL-1 ..... N91-20544 #
AMSMI-CR-RD-AS-90-3-VOL-2 ..... N91-20545 #
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Government Publications/Maps Dept.
Lexington, KY 40506
(606) 257-8400

## *LOUISIANA*

**LOUISIANA STATE UNIVERSITY**
Middleton Library
Government Documents Dept.
Baton Rouge, LA 70803
(504) 388-2570

**LOUISIANA TECHNICAL UNIV.**
Prescott Memorial Library
Government Documents Dept.
Ruston, LA 71272
(318) 257-4962

## *MAINE*

**UNIVERSITY OF MAINE**
Raymond H. Fogler Library
Govt. Documents & Microforms Dept.
Orono, ME 04469
(207) 581-1680

## *MARYLAND*

**UNIVERSITY OF MARYLAND**
McKeldin Library
Documents/Maps Room
College Park, MD 20742
(301) 454-3034

## *MASSACHUSETTS*

**BOSTON PUBLIC LIBRARY**
Government Documents Dept.
666 Boylston Street
Boston, MA 02117
(617) 536-5400 ext.226

## *MICHIGAN*

**DETROIT PUBLIC LIBRARY**
5201 Woodward Avenue
Detroit, MI 48202
(313) 833-1409

**LIBRARY OF MICHIGAN**
Government Documents
P.O. Box 30007
735 E. Michigan Avenue
Lansing, MI 48909
(517) 373-1593

## *MINNESOTA*

**UNIVERSITY OF MINNESOTA**
Wilson Library
Government Publications
309 Nineteenth Avenue South
Minneapolis, MN 55455
(612) 373-7813

## *MISSISSIPPI*

**UNIV. OF MISSISSIPPI LIB.**
Government Documents Dept.
106 Old Gym Bldg.
University, MS 38677
(601) 232-5857

## *MISSOURI*

**University of Missouri at Columbia Library**
Government Documents
Columbia, MO 65201
(314) 882-6733

## *MONTANA*

**UNIV. OF MONTANA**
Mansfield Library
Documents Division
Missoula, MT 59812
(406) 243-6700

## *NEBRASKA*

**UNIVERSITY OF NEBRASKA - LINCOLN**
Love Memorial Library
Documents Department
Lincoln, NE 68588
(402) 472-2562

## *NEVADA*

**UNIV. OF NEVADA-RENO LIB.**
Govt. Pub. Department
Reno, NV 89557
(702) 784-6579

## *NEW JERSEY*

**NEWARK PUBLIC LIBRARY**
U.S. Documents Division
5 Washington Street
P.O. Box 630
Newark, NJ 07101
(201) 733-7812

## *NEW MEXICO*

**UNIVERSITY OF NEW MEXICO**
General Library
Government Publications/Maps Dept.
Albuquerque, NM 87131
(505) 277-5441

**NEW MEXICO STATE LIBRARY**
325 Don Gaspar Avenue
Santa Fe, NM 87501
(505) 827-3826

## *NEW YORK*

**NEW YORK STATE LIBRARY**
Documents Sect. Cultural Educ. Ctr.
Empire State Plaza
Albany, NY 12230
(518) 474-5563

## *NORTH CAROLINA*

**UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL**
Davis Library 080A
BA/SS Department Documents
Chapel Hill, NC 27514
(919) 962-1151

## *NORTH DAKOTA*

**NORTH DAKOTA STATE UNIVERSITY LIBRARY**
Government Documents Dept.
Fargo, ND 58105
(701) 237-8352
In cooperation with Univ. of North Dakota, Chester Fritz Library
Grand Forks

## *OHIO*

**STATE LIBRARY OF OHIO**
Documents Section
65 South Front Street
Columbus, OH 43266
(614) 644-7051

## *OKLAHOMA*

**OKLAHOMA DEPT. OF LIBRARIES**
Government Documents
200 NE 18th Street
Oklahoma City, OK 73105
(405) 521-2502, ext. 252

**OKLAHOMA STATE UNIV. LIB.**
Documents Department
Stillwater, OK 74078
(405) 624-0489

## *OREGON*

**PORTLAND STATE UNIV.**
Millar Library
934 SW Harrison - P.O. Box 1151
Portland, OR 97207
(503) 229-3673

## *PENNSYLVANIA*

**STATE LIBRARY OF PENN.**
Government Publications Section
Box 1601
Walnut St. & Commonwealth Ave.
Harrisburg, PA 17105
(717) 787-3752

## *SOUTH CAROLINA*

**CLEMSON UNIV. COOPER LIB.**
Documents Department
Clemson, SC 29634
(803) 656-5174
In cooperation with Univ. of South Carolina, Thomas Cooper Library, Columbia

## *TEXAS*

**TEXAS STATE LIBRARY**
Public Services Department
P.O. Box 12927 - 1201 Brazos
Austin, TX 78711
(512) 463-5455

**TEXAS TECH. UNIV. LIBRARY**
Documents Department
Lubbock, TX 79409
(806) 742-2268

## *UTAH*

**UTAH STATE UNIVERSITY**
Merrill Library & Learning Resources Center, UMC-30
Documents Department
Logan, UT 84322
(801) 750-2682

## *VIRGINIA*

**UNIVERSITY OF VIRGINIA**
Alderman Library
Government Documents
Charlottesville, VA 22903
(804) 924-3133

## *WASHINGTON*

**WASHINGTON STATE LIBRARY**
Document Section
Olympia, WA 98504
(206) 753-4027

## *WEST VIRGINIA*

**WEST VIRGINIA UNIV. LIB.**
Government Documents Section
P.O. Box 6069
Morgantown, WV 26506
(304) 293-3640

## *WISCONSIN*

**ST. HIST SOC. OF WISCONSIN LIB.**
Government Pub. Section
816 State Street
Madison, WI 53706
(608) 262-2781
In cooperation with Univ. of Wisconsin-Madison, Memorial Library

**MILWAUKEE PUBLIC LIBRARY**
Documents Division
814 West Wisconsin Avenue
Milwaukee, WI 53233
(414) 278-3065

## *WYOMING*

**WYOMING STATE LIBRARY**
Supreme Court & Library Bldg.
Cheyenne, WY 82002
(307) 777-5919

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